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Electronics

THE WORLDWIDE TECHNOLOGY WEEKLY

SEPTEMBER 9, 1985

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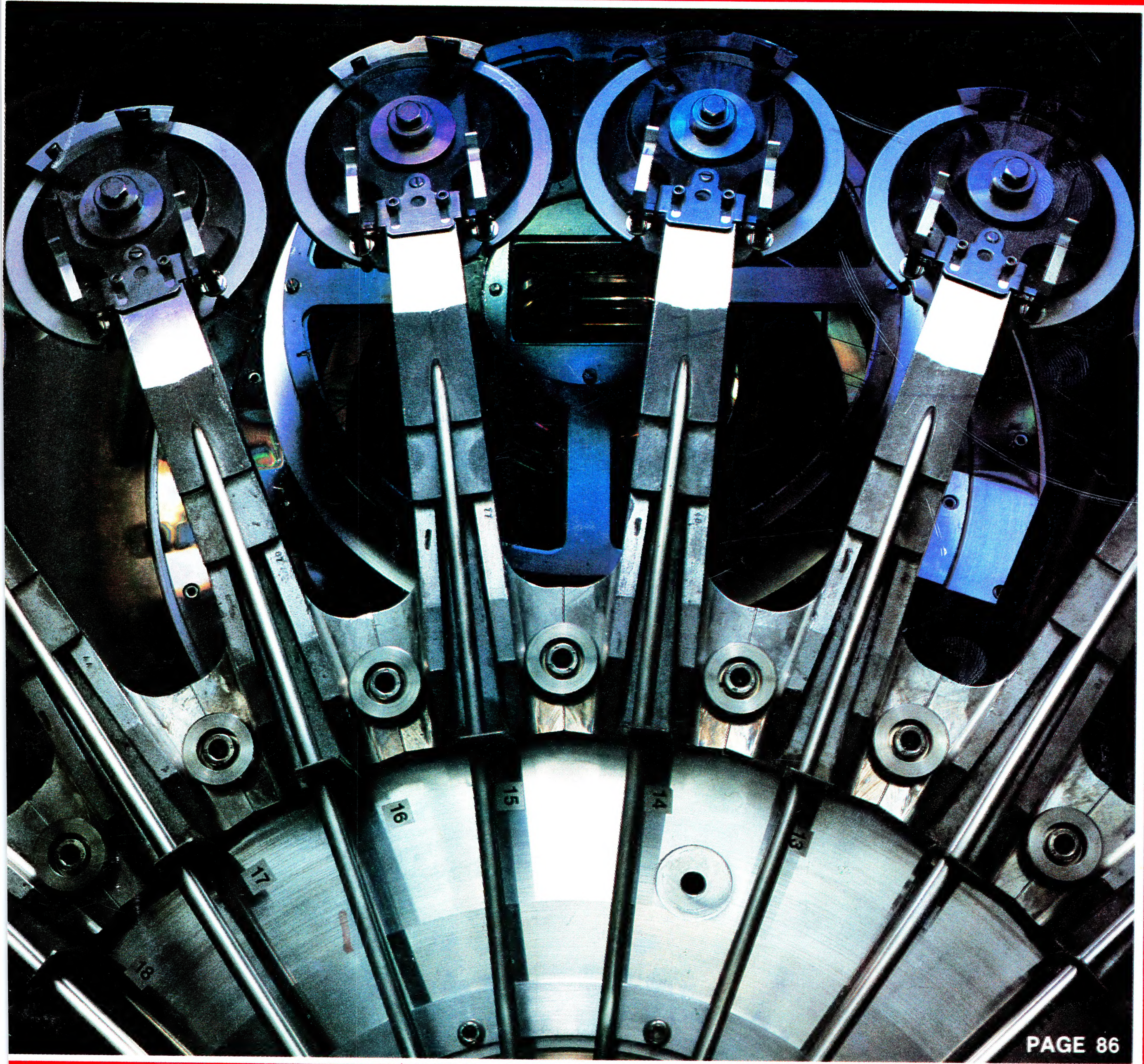
HERE COMES A NEW BREED OF IMPLANTER



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DESIGN › ANALYSIS › VERIFICATION › LAYOUT › INTERFACE › TEST

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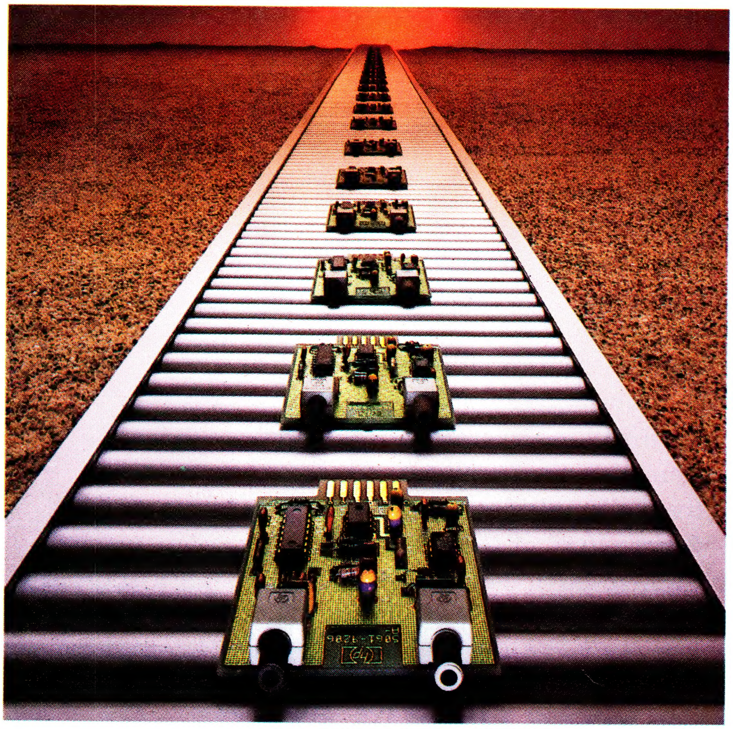

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HP's new miniature fiber-optic components are housed in an integrated dual-in-line package designed for high-volume manufacturing—just like any other IC chips.

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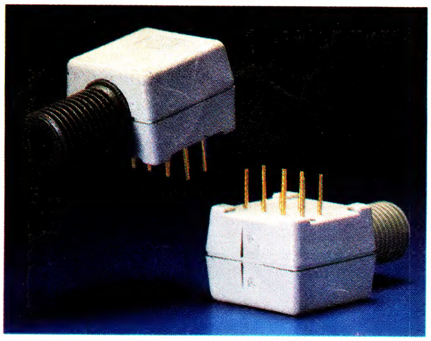

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Electronics

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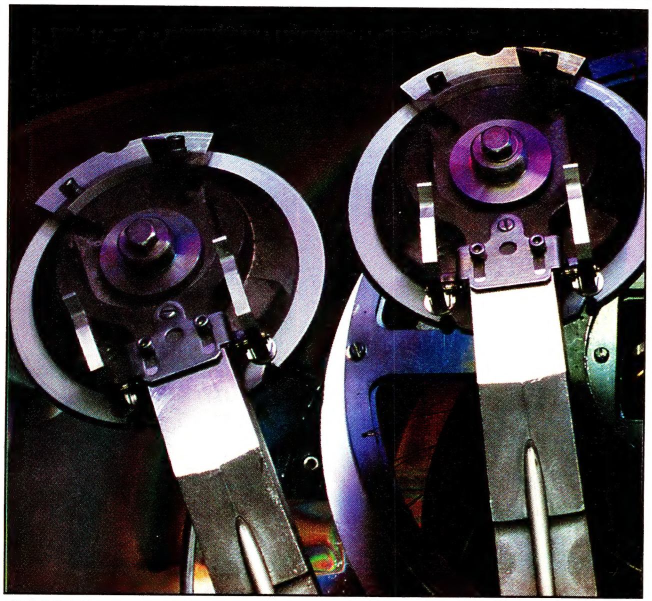

COVER: A new breed of ion implanter arrives, 86
The next generation of fine-geometry chips will require a new breed of ion implanters, so Applied Materials Inc. set out to develop a machine that radically reduces contamination and ensures highly precise repeatability. The result is a fully automated system that boosts throughput fourfold.

Getting R&D help from other nations, 89
To develop its ion implanter, Applied Materials garnered funds from the UK—a tactic that is also working in Japan

SPECIAL REPORT

Superfast ICs herald new supercomputer era, 92
Future supercomputers and minisupercomputers won't show up until denser, higher-performance ICs do, so chip makers and computer designers are stretching the IC state of the art. They're also looking at technologies beyond silicon and GaAs

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The much-discussed Manufacturing Automation Protocol is finally beginning to spawn products. Because Intel Corp. expects MAP to dominate data transfer on the factory floor, it plans a major assault on the market with a broad product line.

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Noting the protests from Congress and U. S. industry about unfair trade overseas, many foreign electronics companies charge that the U. S. has trade barriers of its own

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Signal Generator SMPD second to none

$g(f)=2\tau\,\frac{\sin 2\pi\tau f}{2\pi\tau f}$
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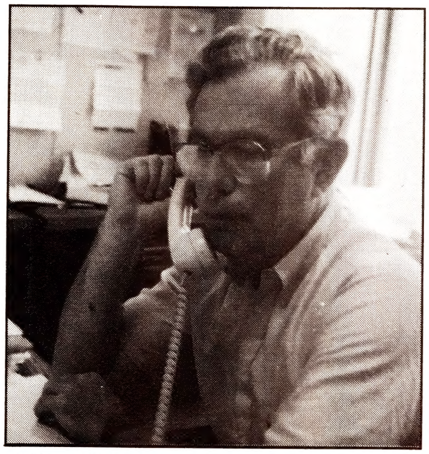
PUBLISHER'S LETTER

This week's cover story can stand as a prototype of how a weekly magazine covers a technology story. When we found out about Applied Materials Inc.'s plans to unveil its new machine, we sent Packaging & Production Editor Jerry Lyman to company headquarters in Santa Clara, Calif., to get the details. Then we assigned Denise Caruso of our Palo Alto bureau to do a story about Applied Materials' international approach to financing its research and development. The result is the package starting on p. 86: Jerry's "Here comes a new breed of ion implanter" and Denise's "Getting R&D help from other nations."

While in California, Jerry also looked in on two makers of semiconductor-processing equipment in addition to Applied Materials. What impressed him most was the fact that, "despite the recession, here were three major manufacturers of processing machinery working on the machines of the 1990s. Despite the bad times, and the layoffs that have become common at their customers' plants, all three companies I visited made major investments in machinery in order to build even better processing equipment. Bad times? These three companies were more interested in looking to the future."



ON THE MOVE. Jerry Lyman was key man in the article on a new breed of ion implanters.

This issue's other major story about emerging technologies, "Superfast ICs herald new supercomputer era" (p. 92), comes from Senior Editor Tom Manuel, who is our lead man covering computers and peripherals. Tom's method was the opposite of Jerry's: for this special report, he never left the office. Rather, he relied on extensive field reporting from *Electronics'* worldwide network of news bureaus—from Charlie Cohen and Jon Joseph in Tokyo, John Gosch in Frankfurt, and Robert Gallagher in Paris—leavened by his own insight, knowledge, and reportorial skills.

Tom reports that the one development he didn't expect to find was the rapid progress that is being made by gallium arsenide technology. "Although there is a good deal of activity in the conventional silicon technologies that we cover in the article—CMOS and bipolar—it appears that we are on the verge of seeing commercial GaAs products."

New memories and gate arrays built in GaAs are discussed in the article. And, as Tom comments, "It is always gratifying to be the first to write about a new development."

Laurence Altman

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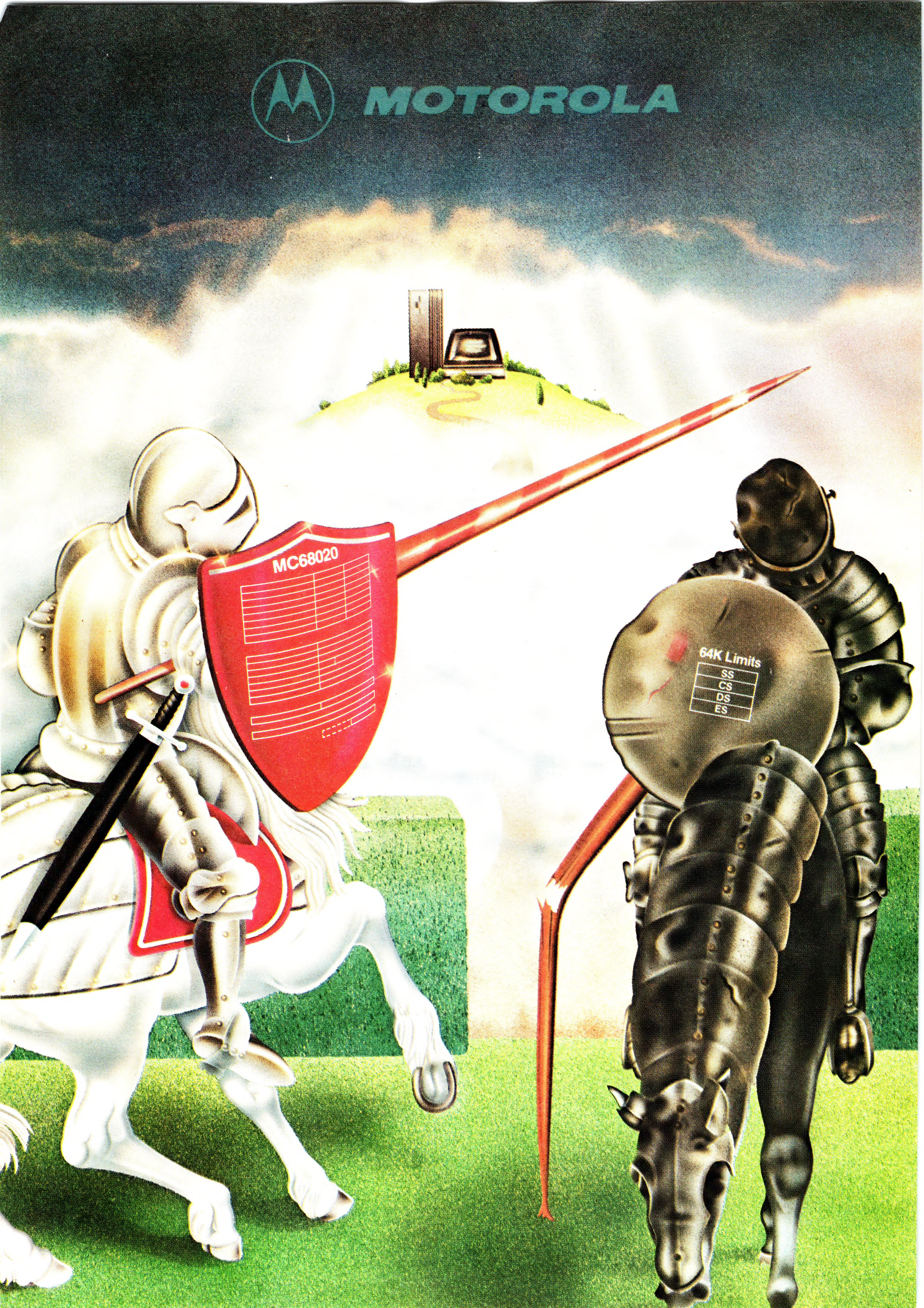
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Outperform your competition.

Motorola's MC68020, MC68881 and MC68851 are the 32-bit solution.

In the battle for product leadership, reliance on an outdated architecture or failure to optimize cost/performance can be fatal. Motorola's MC68020 and powerful peripherals are the 32-bit solution to systems that outperform their competition.

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- Complete 32-bit performance-oriented architecture and massive linear address space.

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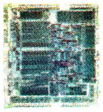
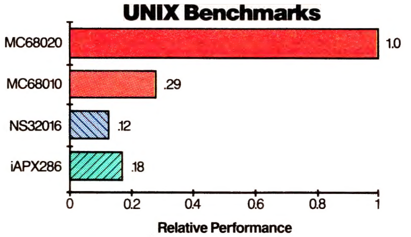
Faster by a mile.



No MPU available today can touch the 2.5 MIPS performance or the 8.3 MIPS burst rate of the MC68020. None even comes close.

In a variety of measured benchmarks, the MC68020 is faster by anywhere from two-to-one up to sixteen-to-one over the closest competitive device, which is usually the 16-bit MC68010, another M68000 Family virtual memory MPU.



Results are the average of measured system performance on systems available June, '85.*

MC68020: Alpha Micro AM-2075
Charles River Data Systems CP-20
Hewlett Packard Series 300, Model 320
MC68010: Sun 2/120
Ironics IV-1600/s
Tektronix 4044
Masscomp MC-500
NS32016: National 3210
iAPX286: Intel 286/310
IBM PC/AT

*Test data on record at Motorola.

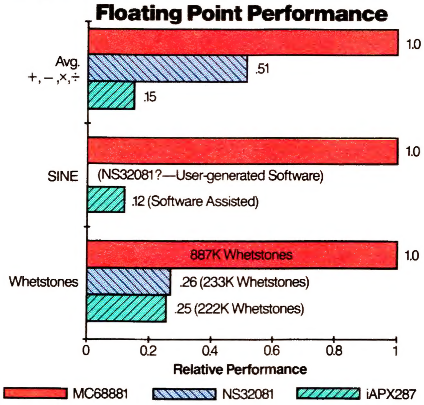
How does the MC68020 so outstrip the others?

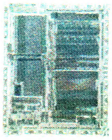
It's a natural outcome of the 32-bit M68000 Family architecture established over the last six years. Seventeen 32-bit general-purpose data and address registers, virtual memory support, linear four-gigabyte address space, on-chip cache and a highly acclaimed instruction set all contribute to performance superiority.

Can 6, 8, and 10 MHz devices hope to match performance with the 12.5 and 16.67 MHz clock rates of the MC68020?

Powerful new Coprocessors.

Addition of the MC68881 Floating Point Coprocessor (FPCP) and MC68851 Paged Memory Management Unit (PMMU) allows creation of a powerful, complete 32-bit system.

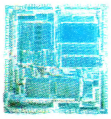




The MC68881 is the only FPCP that meets and exceeds the IEEE standard. It not only includes the basic add, subtract, multiply and divide, but also performs a full selection of transcendental and non-transcendental functions — root values, trig functions, exponentials, logs and more. All functions are in hardware. No external software is required.

MC68881 performance? Unapproached. Customers have reported up to 1000K Whetstone performance, 4x the performance of the fastest competitive devices.

Also, concurrent MC68881 operation with the main processor frees the MC68020 for continuous operation on other tasks.



The MC68851 PMMU efficiently supports a demand paged virtual memory environment for multi-user and multi-tasking systems. The PMMU, with an on-chip translation cache, performs a logical-to-physical address translation in 60 ns. The PMMU provides unique features such as variable page sizes and optional number of tables that aren't available with any competitive device.

Upward code compatibility increases the advantage.

The upward code compatibility of the M68000 Family permits your product family, as it evolves, to incorporate the performance improvements of the MC68020 without massive code rewrites. And, dynamic bus sizing allows plugging the MC68020 directly into existing 8- and 16-bit systems for performance upgrades.

Low HCMOS power dissipation.

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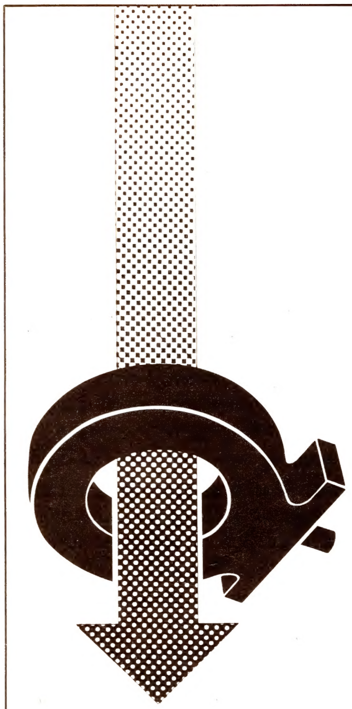

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MEETINGS

ICCD '85: International Conference on Computer Design, IEEE (ICCD '85, P. O. Box 639, Silver Spring, Md. 20901), Rye Town Hilton, Port Chester, N. Y., Oct. 7-10.

ADEE East '85: Automated Design and Engineering for Electronics Exposition and Conference, Cahners Exposition Group (Cahners Plaza, 1350 E. Touhy Ave., Des Plaines, Ill. 60018), Bayside Exposition Center, Boston, Oct. 15-17.

ISA/85, Instrument Society of America (67 Alexander Dr., Research Triangle Park, N. C. 27709), Civic Center, Philadelphia, Oct. 21-24.

Northcon/85, IEEE *et al.* (Electronic Conventions Management Inc., 8110 Airport Blvd., Los Angeles, Calif. 90045), Coliseum, Portland, Ore., Oct. 22-24.

Expert Systems in Government Symposium, IEEE and Mitre Corp. (Expert Systems Symposium, 1109 Spring St., Suite 300, Silver Spring, Md. 20910), Tyson's Westpark Hotel, McLean, Va., Oct. 23-25.

ATE Central '85, Morgan-Grampian Expositions (1050 Commonwealth Ave., Boston, Mass. 02215), O'Hare Exposition Center, Rosemont, Ill., Oct. 28-31.

International Telemetering Conference, ITC Committee (Darrel J. Gabel, U. S. Air Force, WSMC/RT, Vandenberg Air Force Base, Calif., 93437), Riviera Hotel, Las Vegas, Nev., Oct. 28-31.

8th International Conference on Pattern Recognition, International Association of Pattern Recognition (Association Française pour la Cybernétique Economique et Technique, ICPR Secretariat, 156, Blvd. Péreire, 75017 Paris, France), Palais des Congrès, Paris, Oct. 28-31.

Systems 85, Munich Trade Fair Corp. (Kallman Associates, 5 Maple Ct., Ridgewood, N. J. 07450-4431), Trade Fair Center, Munich, Oct. 28-Nov. 1.

Federal High Tech '86, National Science Foundation, U. S. Department of Energy *et al.* (Foresight Science & Technology Inc., 2000 P Street, N. W., Suite 305, Washington, D. C. 20036), Amfac Hotel and Resort, Dallas, Oct. 29-30; Marriott Copley Place, Boston, Nov. 25-26.

Flat Information Displays Conference, Stanford Resources Inc. and International Planning Information Inc. (IPI Inc., 164 Pecora Way, Portola Valley, Calif. 94025), Red Lion Inn, San Jose, Calif., Oct 29-30.

5th Infrared Information Exchange Meeting, Agema Infrared Systems (550 County Ave., Secaucus, N. J. 07094), Royal Orleans Hotel, New Orleans, Oct. 29-31.

Electronic Displays '85, Networks Events Ltd. (Printers Mews, Market Hill, Buckingham, MK18 1JX, England), Kensington Exhibition Centre, London, Oct. 29-31.

Federal Office Automation Conference, National Council for Education on Information Strategies (Irwin Mesch, Federal Office Automation Conference, P. O. Box N, Wayland, Mass. 01778), Washington Convention Center, Washington, Oct. 29-31.

Information: The Force and Its Future, The Information Industry Association (316 Pennsylvania Ave., S. E., Suite 400, Washington, D. C. 20003), Shoreham Hotel, Washington, Nov. 3-6.

Conference on Advanced Medical Computer Applications, Princess Grace Hospital (Hippocrate 2001, Princess Grace Hospital, Monte Carlo), Congress Center, Monte Carlo, Nov. 4-6.

International Electronic Components Exhibition, French Federation of Electrical and Electronics Industries (SDSA, 20 rue Hamelin, 75116 Paris, France), North Paris Exhibition Grounds, Paris, Nov. 4-8.

Gomac-85: Government Microcircuit Applications Conference, Department of Defense *et al.* (Palisades Institute for Research Services Inc., 201 Varick St., Suite 1140, New York, N. Y. 10014), Marriott Hotel, Orlando, Fla., Nov. 5-7.

ISHM '85: International Symposium on Microelectronics, International Society for Hybrid Microelectronics (P. O. Box 3255, Montgomery, Ala. 36109), Disneyland Hotel, Anaheim, Calif., Nov. 11-14.

1st International Conference and Exhibit on Computer Work Stations, IEEE (1109 Spring St., Suite 300, Silver Spring, Md. 20910), Convention Center, San Jose, Calif., Nov. 11-15.

Iecon '85: 11th IEEE Industrial Electronics Society Conference, IEEE (Ravi Prakash, Thomas J. Watson Research Center, Mail Stop 3-249, P. O. Box 218, Yorktown Heights, N. Y. 10598), Hyatt Regency, San Francisco, Nov. 18-22.

Wescon '85, IEEE (Electronics Conventions Management Inc., 8110 Airport Blvd., Los Angeles, Calif. 90045), Moscone Convention Center, San Francisco, Nov. 19-22.

Comdex/Fall '85, The Interface Group Inc. (300 First Ave., Needham, Mass. 02194), Convention Center *et al.*, Las Vegas, Nev., Nov. 20-24.

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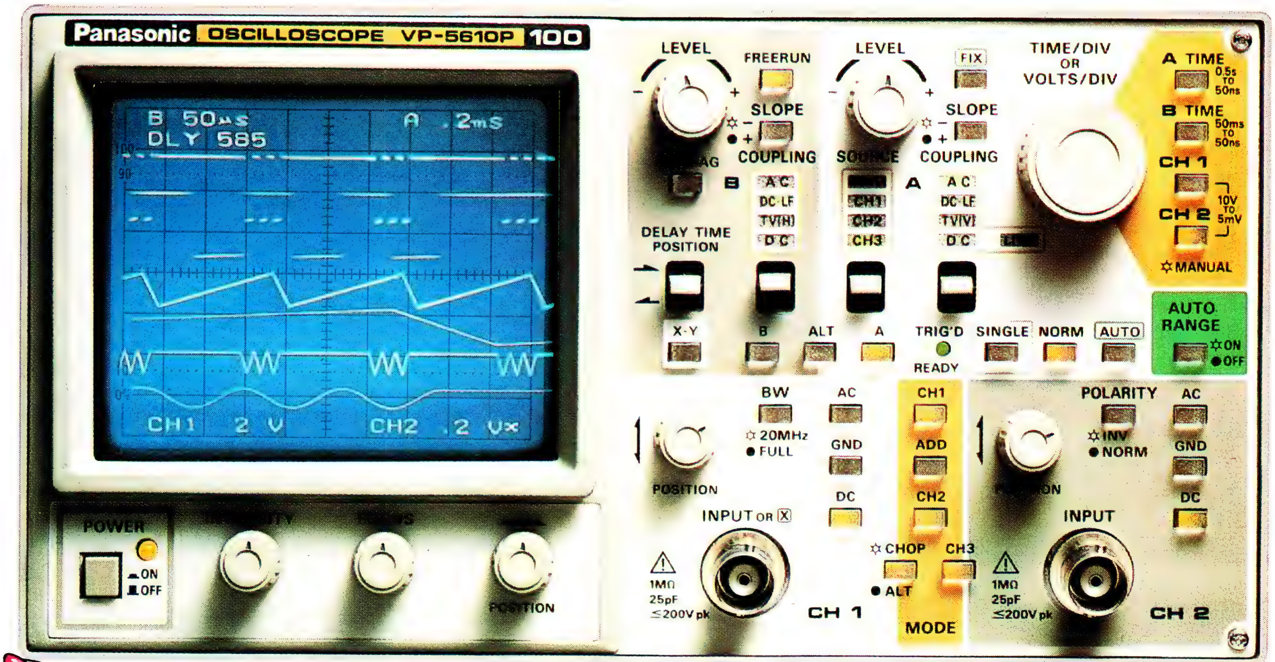
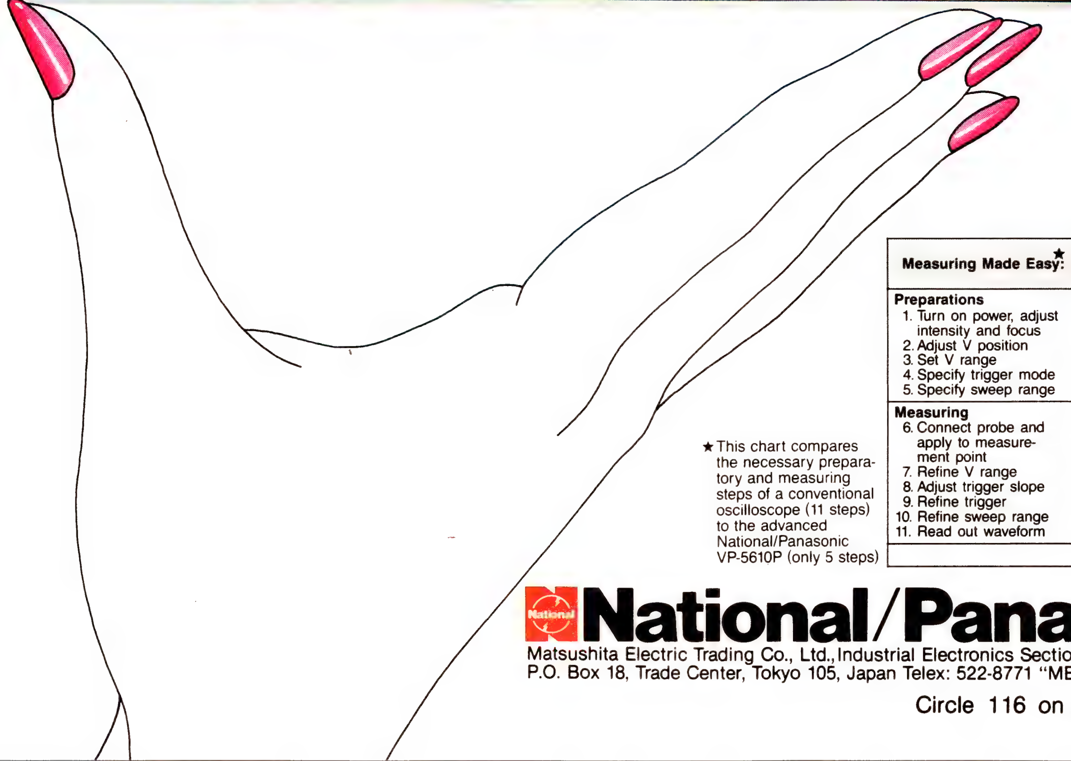


194(W)×102(H) mm



Measuring Made Easy:★	Conventional Oscilloscope	National/ Panasonic VP-5610P
Preparations		
1. Turn on power, adjust intensity and focus	●	●
2. Adjust V position	●	●
3. Set V range	●	
4. Specify trigger mode	●	
5. Specify sweep range	●	
Measuring		
6. Connect probe and apply to measurement point	●	●
7. Refine V range	●	
8. Adjust trigger slope	●	●
9. Refine trigger	●	
10. Refine sweep range	●	
11. Read out waveform	●	●
	11 steps	5 steps

★This chart compares the necessary preparatory and measuring steps of a conventional oscilloscope (11 steps) to the advanced National/Panasonic VP-5610P (only 5 steps)

National/Panasonic

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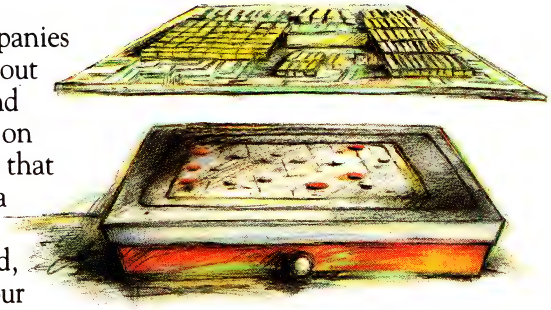

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ELECTRONICS NEWSLETTER

TOSHIBA VCR STORES IMAGES ON DRAMs FOR STILLS AND SLOW MOTION

Thanks to the decline in prices, dynamic random-access memory chips are appearing in consumer products. On Oct. 1, Toshiba will start selling in Japan a video cassette recorder that uses digital memory for freeze-frame and slow-play capabilities. For recording and playback, the VCR operates in the standard analog mode. For stills and slow playback, the machine digitizes the TV signal at a sampling rate of 10.74 MHz, with an accuracy of 6 bits per sample—the minimum acceptable accuracy. The digitized signal is stored in four 64-K-by-4-bit and two 64-K-by-1-bit DRAMs, connected as three banks of 64-K by 6 bits, with an access time of 120 ns. ☐

TEXAS INSTRUMENTS MAY SECOND-SOURCE INMOS TRANSPUTER

The transputer, a microprocessor developed for use in parallel processing, has piqued the interest of the semiconductor industry's biggest player, Texas Instruments Inc., which could seek a second-source agreement with the transputer's originator, Inmos International plc of Bristol. For the past two years, TI's Industrial Systems Division, through its Bedford, England, operation, has been investigating the application of the transputer in industrial-control, flexible-manufacturing, and communications-control systems. The transputer is ideal for those applications because it is designed to work in distributed systems. Recently, the Bedford group accelerated software development by enlisting the help of Meiko Ltd., a Bristol startup formed to develop products based on the transputer [*Electronics*, July 29, 1985, p. 13].

But TI's Industrial Systems Division, headquartered in Johnson City, Tenn., could be reluctant to press ahead with commercial products based on the transputer because it cannot ensure supplies of an item it does not make. Inmos, meanwhile, is due to launch the transputer family of 16- and 32-bit chips in October with volume production beginning in 1986. It acknowledges that its transputer must eventually be second-sourced but is in no hurry to seek a partner until the transputer's market acceptance is ensured. ☐

RECORD CONVERSION RATE CLAIMED FOR NEW SOLAR CELL

The use of thin-film amorphous silicon for solar cells could get a boost from the latest work of Sovonics Solar Systems Inc., a joint venture of Standard Oil Co. (Ohio), Cleveland, and Energy Conversion Devices Inc., Troy, Mich. Sovonics says it has set a world energy-conversion record of 12.2% in a 1-cm^2 amorphous-silicon solar cell. The 12% conversion level is the target of several research projects in amorphous silicon [*Electronics*, April 5, 1984, p. 94]. The Sovonics achievement is a triple-level design that stacks three extremely thin vertical layers of fluorinated amorphous materials. Each layer absorbs a different color of the spectrum and should retain 90% of its stability over 20 years, reports Sovonics. ☐

AT&T READY TO SAMPLE ITS 1-MB RAM

Equipment makers who are designing products that could use 1-Mb dynamic random-access memories can now count on a U. S. supplier—AT&T Co. The company's Components and Electronic Systems Division reported last week that it had 1-Mb chips ready for sampling by outside customers and that it expected to begin limited production before the end of the year. Full production at AT&T's Allentown, Pa., plant will begin early next year, according to John Nemecek, the division's executive vice president. Internally, AT&T intends to the use chips in its 5ESS electronic central-office switch, the 3B family of minicomputers, private-branch-exchange systems, and personal computers. No price has been set for open-market sales. ☐

ELECTRONICS NEWSLETTER

LUCITRON PROMISES DELIVERY OF BIG FLAT-PANEL DISPLAY—AGAIN

After more than seven years of work and several postponements in the delivery date, Lucitron Inc. says it will finally deliver the first of two demonstration units of a 34-in. diagonal dc plasma flat-panel display before year end. The Northbrook, Ill., company built the unit under contract to the Naval Ocean Systems Center, San Diego, because the U. S. Navy is interested in using the technology for command and control applications. Delivery-date promises on the 5-in.-thick Flatscreen Gas-Electron-Phosphor display go back to 1981 [*Electronics*, April 21, 1983, p. 32 and May 5, 1981, p. 12]. But the company had difficulties with the mechanical assembly of the unit in alignment of parts and hermetic sealing and faced a shortage of suitable custom components. Those problems have been licked, claims Alan Sobel, one of three former Zenith Radio Corp. researchers who founded the company in 1981 after Zenith abandoned the technology. The initial demonstration unit is monochrome, but Lucitron says that color versions will be available next year. It is seeking $6 million to set up a pilot production line and expects to ship eight Flatscreen units to military and commercial customers next year. The price will be about $45,000 per unit, but Lucitron figures the price will drop to about $4,000 by 1990, once it gets into volume production. ☐

JVC VIDEO DISK ENTERS THE U. S. IN EDUCATIONAL SYSTEM

Victor Co. of Japan will bring a grooveless version of RCA Corp.'s capacitive-pickup video-disk system to the U. S. market in October, about a year and a half after RCA ceased production of its grooved consumer product [*Electronics*, April 19, 1984, p. 52]. JVC's turnkey Video Home Disk training system will be part of an interactive educational system from National Education Corp., Newport Beach, Calif., which developed the software. ☐

CALIFORNIA UNITARY-TAX RELIEF CHANCES SLIM

Getting rid of California's unitary tax this year seems unlikely as the state legislature moves into its final week. A unitary tax requires a company to base its payments to the state on its worldwide income, rather than on just its income earned in that state. The original California bill would have encouraged foreign investment by exempting non-U. S. companies from the worldwide requirement. Many California electronics companies opposed the bill because it did not provide them similar relief. Democrats added amendments to include domestic companies and to exclude multinationals making new investments in South Africa—but then Republican support dropped off. ☐

ARE WORLD TELECOM MARKETS HEADED FOR ANARCHY?

The world's telecommunications markets are heading for a period of anarchy as rapid technological advances outpace the ability of policymakers to regulate the industry. This gloomy outlook comes from the International Institute of Communications, a research body in London. Technical advances are destroying the dividing lines between computing and telecommunications and are creating new services such as data transmission by satellite, the institute says in a new report.

Governmental responses fall broadly into two camps, according to the institute. On the one hand, Britain and Japan have followed the U. S. in allowing competition in basic transmission services. By contrast, continental European countries will maintain their monopolies over public telecommunications for the foreseeable future. Such policy differences could lead to friction among countries, says the report, and countries that fail to respond to technological change and keep tariffs high will pay a heavy price in lost revenue. ☐

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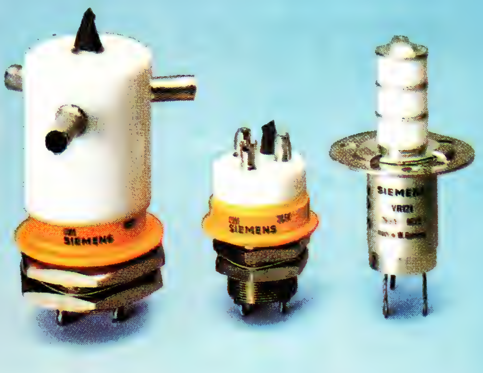


Electronics

NEW FET DESIGN COULD SPEED THE ARRIVAL OF 3-D CIRCUITS

DEVICE DEVELOPED BY JAPANESE LAB SOLVES SHORT-CHANNEL PROBLEM

TSUKUBA, JAPAN

Three-dimensional integrated circuits promise eye-opening densities and performance. In the quest for these ICs, most researchers have concentrated on improving the quality of the recrystalized layers needed to build 3-d circuits. At the Japanese government's Electrotechnical Laboratory, however, scientists are taking a different tack. They have devised a MOS FET configuration, called XMOS, that should speed the eventual arrival of 3-d ICs.

The new structure eliminates the short-channel effects that plague MOS FETs with submicron channel lengths. At the same time, it does away with crosstalk from underlying active layers in a device. What's more, the new design, with its added bottom gate, also provides either threshold-voltage control or an additional input terminal.

GATE-CHANNEL SANDWICH. Toshihiro Sekigawa, senior researcher, and Yutaka Hayashi, section head, of the laboratory's Semiconductor Device Section, call the configuration XMOS because it resembles an upper-case Greek letter Ξ (X). The upper and lower bars are gates; the shorter bar sandwiched between them is the channel. Besides controlling current flow through the channel, the two gates shield it from electrical interference.

Typically, XMOS transistors are built on top of a 500-nm-thick silicon dioxide layer on a silicon substrate. The device sandwich includes a 440-nm polysilicon lower gate, a 25-nm lower gate oxide, a 200-nm active recrystalized silicon channel region, a 20-nm upper gate oxide, and an upper polysilicon gate (see figure).

Only the channel region and immediately contiguous portions of the drain and source are recrystalized. The argon laser beam being used as a heat source is not shaped, and the recrystalization is not seeded.

This simplified recrystalization scheme is employed so that the researchers can fabricate devices at minimum cost and effort. Lattice orientation of the recrystalized regions undoubtedly varies, but samples are adequate to perform initial experiments. In the future the researchers will have to work with devices whose recrystalized regions have been seeded for more precise measurements.

Short-channel effects are possibly the major problem facing designers of submicron FETs. When channel length decreases in the submicron range below a certain value determined by geometry and doping, threshold voltage decreases rapidly from its long-channel value. This severely cuts back yield because channel length can vary as a result of fluctuations in the fabrication process.

Furthermore, the electric field tends to punch through the substrate under the channel between the drain and the base. The traditional method of coping with short-channel effects is to increase substrate doping concentration. But at 10^{18} atoms per cubic centimeter, zener breakdown occurs; at 10^{19} atoms per cc, tunneling starts. Lightly doped drains help overcome breakdown and tunneling, but the XMOS configuration should prove to be more effective.

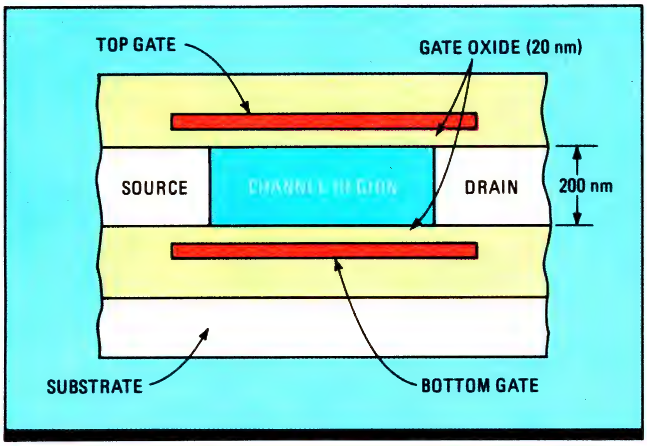
In the XMOS transistor, the threshold voltage remains constant down to shorter channel lengths because the electric field from the drain terminates on the lower gate rather than extending under the channel. Punchthrough is prevented for the same reason. This improvement in characteristics makes it possible to have a thinner recrystalized silicon layer, but there is a limit. A certain minimum thickness is required for high repeatability and yield. The optimum thickness is not yet known because development of recrystalization processes is still at an early stage.

Even without going to extremes, it is advantageous to keep the recrystalized-layer thickness to 200 nm or less. Calculations show that for devices with a 300-nm thickness of the recrystalized layer, the subthreshold slope of drain current as a function of gate voltage is about 80 mV for each tenfold increase in current. When the thickness is 200 nm, the slope changes to the theoretical minimum value of about 60 mV per decade. This means that devices can operate at lower power-supply voltages, which will be required for operation of devices with submicron channel lengths [*Electronics*, July 15, 1985, p. 36].

ADDED FLEXIBILITY. Moreover, a small bias on one of the gates can be used to shift the threshold of the other gate. This provides an additional element of flexibility that makes it possible to optimize doping levels and dimensions to match other requirements and set threshold level by bias control.

Both gates exert similar control on current in the channel. When the lower gate voltage is fixed at zero and the upper gate voltage is increased, the majority of the current flows in the upper portion of the channel. When the upper gate voltage is fixed at zero and the lower gate voltage rises, the majority of the current flows in the lower portion of the channel. Separate signals can be fed to the individual gates to provide OR logic, because the gates exert similar control of channel current.

The voltage on the gates is usually determined by the circuits to which they connect. Thus they shield the channel from fields originating in the device's lower or upper active layers. *–Charles L. Cohen*



TWO GATES. A new FET structure from Japan's Electrotechnical Laboratory puts one gate above and another below the channel.

MATERIALS

GOLD'S GRIP ON CONNECTORS IS SLIPPING

CHICAGO

There are strong signs that substitutes for gold—particularly palladium and palladium-nickel alloys—will soon own a large portion of the market for connector contacts. Gold coatings are still used in most connectors, but gold's high and volatile price has motivated extensive research on alternatives, and many of the new materials' problems have been ironed out.

Electronics giants such as AT&T Co. and Siemens AG are stepping up internal use of substitutes to cut costs, and several merchant connector suppliers are either stepping up promotion or offering new alternatives to gold.

Substitutes were first used when gold prices skyrocketed in the late 1970s. But when gold prices dropped from their 1980 peak of $875 per ounce to as low as $320, adoption of substitutes became less urgent. Now, by one estimate, connectors using substitute plating materials account for only about 2% of merchant sales. But this does not include their increased popularity in parts made and used internally by large companies.

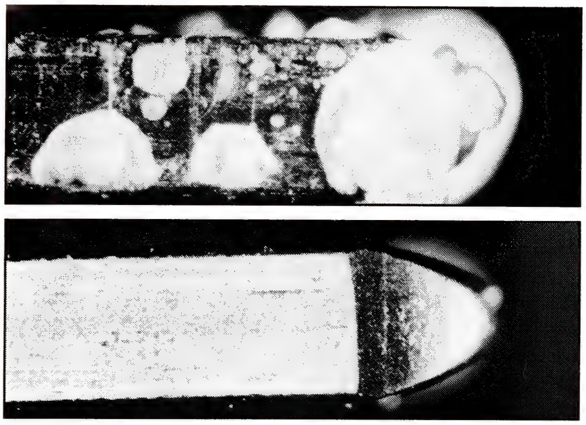
"As some of the bigger companies such as AT&T develop their own [gold substitutes], it's helping to spur broader acceptance," says Kenneth A. Bushman, product marketing manager for Dupont Connector Systems in New Cumberland, Pa. "We're seeing broad-based acceptance of gold substitutes even at the price of gold today."

NEW INTEREST. Dupont is one of the few connector houses actively promoting its gold substitute, but others are stirring. One is Robinson Nugent Inc. This week, the New Albany, Ind., connector maker is introducing Robex, a gold-flashed palladium-nickel plating. The company says the plating will equal or surpass the performance of gold on a thickness-for-thickness basis [*Electronics*, Sept. 2, 1985, p. 11].

Robex is initially being offered only on Robinson Nugent insulation-displacement socket connectors and headers. But the company is prepared to make it available across its entire line if it gains acceptance, says Benjamin M. Mattox, product marketing specialist. "Right now, we want to be in a position where if the gold market suddenly goes up, we are ready to go," says Stephen W. Updegraff, manager of research and development.

In Lisle, Ill., the Amphenol Products unit of Allied Inc. also plans to introduce a gold-substitute plating option "possibly before the end of the year and absolutely by next year," says a company official. Amphenol Products will say little about the plating except that it is based on a nickel alloy.

At Dupont (known until this year as Berg Electronics), Bushman confirms that his company's GXT palladium-nickel plating, brought out in 1982, has been slow to take off despite being priced 10% to 20% lower than comparable gold-plated connectors. But Dupont has now accumulated enough performance data to allay customer concerns, Bushman says. As a result, GXT orders picked up significantly last year, particularly among cost-conscious volume customers. The company has recently expanded GXT availability from one connector line to more than a dozen.



ACID TEST. An hour in a nitric-acid vapor corroded a connector pin with a 30-μin. layer of gold (at top). A pin with a similar thickness of Robinson Nugent's Robex had very little damage.

The alternatives to gold can produce dramatic savings. AT&T's proprietary plating process, which lays down 25 microinches of palladium and covers it with a 1-to-2-μin. gold flash, saves about 75% in precious-metal costs and provides equal or better performance than connectors plated with 25 to 30 μin. of gold, according to Harvey Trop, a supervisor at the Chemical Process Control and Automation Department at AT&T Bell Laboratories in Murray Hill, N. J.

AT&T is now converting to gold-flashed palladium for all of its internally made electroplated connectors. When the project is complete in early 1986, AT&T will be applying palladium to billions of pins annually and saving "tens of millions of dollars" per year, says Trop, who is coinventor of the AT&T plating and the plating process.

Palladium alloys are catching on as substitutes

Some industry experts are adamant that gold prices will have to rise dramatically again before substitute connector platings make significant inroads. Among them is William H. Abbott, project manager for electronics materials reliability at Battelle Columbus (Ohio) Laboratories, an independent testing house. He cites corporate inertia associated with in-place gold-plating equipment, gold's proven performance, and some users' lingering concerns over the long-term reliability of substitutes. Like others, he says that selective-plating procedures developed since the gold price crisis five years ago have "done a lot to reduce gold usage," and thus are reducing the pressure for cheaper materials.

Proponents of substitutes, however, contend that early problems with the materials have been overcome. AT&T's palladium-plating process has been designed to stop the palladium from absorbing hydrogen produced by electrolysis during the process, Trop says. This helps eliminate later cracking or peeling of the palladium. At Robinson Nugent, Updegraff says that his company's bath formula and plating process produces a less porous covering than that of earlier palladium-nickel coatings. The result, he says, is the elimination of contact-resistance problems caused by corrosion from chemicals that attack base metals through the pores.

At Siemens, officials concede a risk of higher contact resistance than that of gold for the company's palladium-plated connectors under certain conditions. But the company believes it has its palladium process well enough in hand to avoid the difficulty. A gold flash atop the palladium results in better wear resistance than is seen with gold, say officials, adding that Siemens has plans to expand its palladium-plating activities.

TOUGH SELL. Even proponents such as Robinson Nugent's Updegraff concede that the promotion of alternative materials could be a tough sell. "Even though we have test results that show this works as well as gold in mild environments and better in harsh environments, the market just doesn't seem ready psychologically," he says.

But Trop feels that substitutes are already in wider use than most in the industry realize. He puts the figure at 10% to 15% of all connectors, when captive applications are considered. If developments in South Africa (the world's major gold producer) force gold prices up, "we would probably see at least 50% penetration very quickly," he says, perhaps within two years. But even without an increase in gold prices, "I think you're going to see a lot of people converting anyway just to reduce their costs." *–Wesley R. Iversen*

MEMORIES

FAST SRAMs POINT WAY TO IMPROVED PROCESSES

AUSTIN, TEXAS

Fast static random-access memories are starting to catch on with some U. S. semiconductor manufacturers as the chip of choice for perfecting mainstream integrated-circuit technologies. The choice is crucial, since it determines how fast chip makers can get into production with the minute geometries and multilayer chip structures needed to compete in the markets for upcoming generations of memories and other complex integrated circuits. And each new generation—after an initial upward bound in price—eventually drives prices to users down.

Some RAM-market watchers believe fickle business conditions, as well as technical developments, are accelerating the swing toward CMOS statics, rather than n-MOS dynamic RAMs, as technology drivers. Although the market for SRAMs is not as large as that for DRAMs (see chart), SRAMs so far have not suffered price drops as precipitous as DRAMs, where Japanese chip makers dominate. "It makes a lot of sense for the U. S. companies to go after SRAMs, where the Japanese competitors are not so far ahead," says James Feldhan, vice president of semiconductor researcher In-Stat Inc., Scottsdale, Ariz.

Motorola Inc., for one, believes that. The company's Memory Products Division in Austin continues to use DRAMs to help ease new high-volume processes down the fabrication learning curve, but its two-year-old push into fast statics has become the principal catalyst for fine-tuning high-speed CMOS for its other memory, logic, microprocessor, and semicustom products. Intel, Harris's Semiconductor Products Division, and Lattice Semiconductor are following similar paths.

In Japan, SRAMs have served as technology drivers for some eight years. Hitachi Ltd., Tokyo, worked its way along the processing learning curve from 3 μm for its 16-K SRAM to the 1.3-μm process used in its 256-K SRAMs. At Toshiba Corp., Kawasaki, statics came to be considered a good vehicle for process development after CMOS SRAM production started in earnest with the 64-K generation, says Yoshio Nishi, senior manager of the Advanced Memory Technology Department. Both companies, however, expect DRAMs to hold their own as development vehicles.

Two technology thrusts are leading the drive. One is an increasing need for fast low-power CMOS technologies, which are ideally suited for the current generation of SRAMs. The other is the advent of double-level-metal processes, which offer faster access times; statics can overcome the increased difficulty of producing these processes.

Two developmental thrusts also are lifting SRAMs to the top of the line for leading-edge developments: the need for new three-dimensional static storage cells that pack more transistors on a chip, and the interest in speedy on-chip storage for application-specific ICs.

"Those are all very valid reasons for greater SRAM emphasis, but it is also becoming a much more attractive market," notes Susan Scibetta, a research associate in the Semiconductor Industry Service of Dataquest Inc., San Jose, Calif. Dataquest estimates that worldwide sales of statics in 1980 were $491 million. If the current market were healthy, statics would now top the $1 billion mark, it says; but the 1985 recession has shrunk the total available market to $890 million. That still is less of a drop than for DRAMs, which are falling this year to only $1.52 billion compared with $3.52 billion last year.

In fast statics—chips with access times faster than 70 ns—Dataquest estimates the market will be $673 million of the $1.79 billion SRAMs market in 1987. The primary source of growth in fast SRAMs has been the emerging new market for low-cost supercomputers, says Gerard Nash, new-product development manager in the memory division at Motorola. SRAM markets now are large enough to provide the volumes needed for breaking in new processes and design techniques, he believes.

Motorola plans to use a double-level-metal CMOS process—one it uses on its current 64-K SRAMs—on its 1-Mb DRAM. In 1986, the company will shrink its leading-edge 1.5-μm CMOS 64-K static process to 1.2 μm for a new 74,000-mil^2 256-K SRAM. "The increasing emphasis on high speeds has made SRAMs more suitable as a development vehicle of the 1980s," says Nash.

HOLDING TIGHT. At Texas Instruments Inc., however, DRAMs still hold sway as the means of reaching maximum manufacturing efficiencies. The Dallas company continues to be the strongest advocate in the U. S. for using dynamics as a commodity process driver. It sees little reason to push SRAMs into that role because it believes complex features of future generations of statics will inevitably spill over to DRAMs.

"A company can now select either DRAMs or SRAMs to drive its general MOS technology because DRAMs are going to CMOS," says Greg Armstrong, development manager for 1-μm CMOS processes at TI. He adds that these parts will almost certainly use double-level-metal processes at the 4-Mb level, but may bypass them at the 1-Mb level.

But for many startups, statics have

Statics challenge dynamic RAMs on leading edge

GROWTH OF STATIC RAMS OUTPACES DYNAMIC RAMS ($ millions)*

	1980	1983	1984	1985	1986	1990
STATIC RAMS						
Total available market*	491	787	1,187	890	1,187	1,948
CMOS*	184	453	746	621	905	1,866
n-MOS*	307	334	441	269	282	82
Average selling price ($)	4.60	3.42	4.22	2.99	3.44	3.41
DYNAMIC RAMS						
Total available market*	1,029	1,803	3,519	1,521	2,056	7,730
Average selling price ($)	4.50	2.90	3.46	1.61	2.02	3.26

SOURCE: DATAQUEST INC.

become the memory vehicle of choice for process development because the part does not require huge manufacturing capacity, says Rahul Sud, president of Lattice Semiconductor Corp., Beaverton, Ore. Lattice expects to become the first U. S. supplier of a 256-K SRAM in October. *–J. Robert Lineback*

MANAGEMENT

WILL MOTOROLA REPLACE FIEBIGER?

PHOENIX, ARIZ.

When James R. Fiebiger—lured by a three-year contract rumored to be worth $2.5 million—signed on as president at troubled Mostek Corp., in Carrollton, Texas, he filled what was then the U. S. semiconductor industry's most visible job vacancy [*Electronics*, Sept. 2, 1985, p. 16].

Now, the most conspicuous vacancy is the one Fiebiger left: assistant general manager of Motorola Inc.'s Semiconductor Products Sector. But before executive vice president and general manager Gary L. Tooker can choose Fiebiger's successor, he'll have to ask himself some tough questions.

The problem, say Motorola watchers in the semiconductor industry and the financial community, is the way the two-man general manager's office at the semiconductor sector headquarters in Phoenix has been structured. It has been organized around Fiebiger's strong product and technology background, which freed Tooker to concentrate on the larger business picture; on marketing, personnel, and manufacturing projects; and on his growing role in the Semiconductor Industry Association.

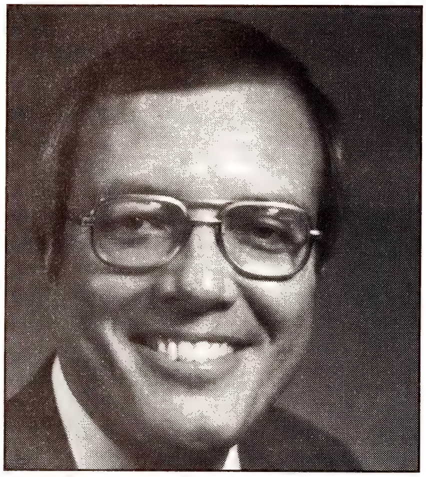
WANTED: TECHNOLOGIST. Fiebiger, with his doctorate in electrical engineering, scored a big success in directing key technology activities. He did so playing essentially the same role as his predecessor, Alfred J. Stein, who is given much of the credit for turning Motorola Semiconductor around between 1977 and 1981, when he left to head up VLSI Technology Inc., a San Jose, Calif., specialist in application-specific integrated circuits.

If Tooker wants to keep the present setup intact, therefore, he must pick a successor who brings similar skills to the post, a difficult task in light of Fiebiger's accomplishments, which stood out enough to attract the Mostek headhunters. The alternative is to downgrade or eliminate the No. 2 position and divide its duties among the six groups created earlier this year when Motorola split its bipolar and MOS operations along product lines.

Motorola has not yet given any hints of its plans: Fiebiger's Aug. 27 resignation happened suddenly, and he departed immediately, just before Motorola's four-day Labor Day holiday. Too, there may be little hurry to replace Fiebiger, given the depressed state of semiconductor orders at present, notes financial analyst James Barlage, first vice president for research at New York's Smith Barney Harris Upham & Co.

Filling the position "is not as critical now as four years ago, when Stein departed [with the turnaound effort not quite completed]," notes Barlage, who has been following Motorola for more than a decade. He terms Fiebiger "clearly an impressive guy . . . and a major factor in the Motorola turnaround as a strong influence on product development and R & D."

Barlage adds that, if Tooker does decide to stick with the Fiebiger mold, with its emphasis on long-range technology matters, the wisdom of his choice won't be clear for some years. "Only then would you know if it's the right guy," he maintains.



DECISION TIME. Gary Tooker must determine what to do about Motorola's No. 2 slot.

Industry analyst William I. Strauss thinks Motorola will move to fill the post without delay. "But they still might use the occasion for reorganizing and shuffling people," says Strauss, who heads Forward Concepts Inc., Tempe, Ariz. *–Larry Waller*

SATELLITE COMMUNICATIONS

TEST FLIGHTS PROVE OUT OCEANIC SATELLITE LINKS

WASHINGTON, D. C.

A series of test flights over the North Atlantic late last month by a team of five organizations showed that two-way aircraft-to-ground data links by satellite are feasible over the ocean. Using an International Maritime satellite (Inmarsat) in a geostationary orbit, the team demonstrated that satellites could improve communications and surveillance in the airspace over the oceans.

"The potential uses of such a system have been demonstrated by the transmission of navigational and other data," says Lawrence E. Deibel of Mitre Corp.'s Systems Development Department, McLean, Va., which led the project. Three years ago, Mitre initiated the project that evolved into the aeronautical satellite-data-link (ASDL) system, designed to show the feasibility and potential uses for low-data-rate digital communications for aircraft that are flying over the North Atlantic.

MIGHTY TEAM. Mitre provided aircraft and earth-station data-link terminals for the project. Communications Satellite Corp., Washington, which made its earth station in Southbury, Conn., available, also provided liaison with the Inmarsat Organization. Rockwell International Corp.'s Collins Avionics divisions, Cedar Rapids, Iowa, supplied a data-link management system and a receiver for the Navstar Global Positioning System.

Rounding out the team were Ball Corp.'s Aerospace Systems Division, Boulder, Colo., which developed two surface-mounted microstrip data-link antennas; and Avantek Inc., Milpitas, Calif., which advised on the manufacture of a satellite communications transceiver in the aircraft's terminal.

Four data-link applications were demonstrated during the flights: automatic communications to the earth station of aircraft position data from the Global Positioning System; two-way communications of messages between the aircraft and the ground; communication of weather data from the ground to the aircraft; and two-way communication of air-traffic-control data.

Satellites can improve communications and surveillance in airspace

The flight plan included a leg from Goose Bay, Newfoundland, to Reykjavik, Iceland, a route considered representative of flights within the North Atlantic tracking system. The test was flown northeast of Reykjavik to assess the performance of the data link as the elevation angle of the satellite decreases and as the incidence angle between the satellite and the antenna on the aircraft changes.

Rockwell International, which also provided a Sabreliner 65 aircraft to carry Mitre's data-link terminal, says the data recorded during the demonstration will be analyzed to determine data-link performance in relation to satellite output power, as well as aircraft location and heading.

MORE TESTS. Mitre's Deibel adds that a further series of tests with the Deutsche Forschungs und Versuchsanstalt für Luft und Raumfahrt, a government-sponsored West German research organization, will begin in early 1986. These tests are intended to collect additional data on the operation of the system under a wider range of propagation conditions. The West German tests will use alternative antenna designs.

There could be more. The Federal Aviation Administration, the International Civil Aeronautics Organization, and the Radio Technical Commission for Aeronautics have shown interest in ASDL as well. *–George Leopold*

DISPLAYS

CRT CAN DISPLAY 4 MILLION PIXELS

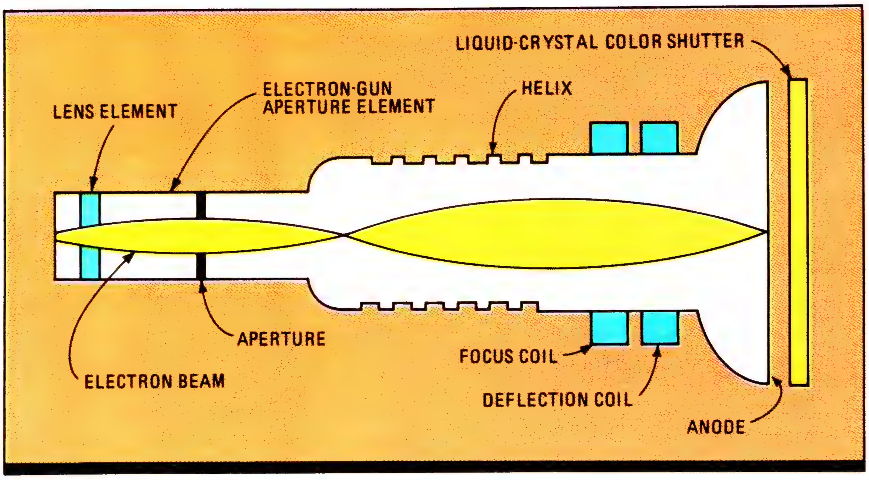
SCOTTS VALLEY, CALIF.

Multiple-electron-beam technology is emerging as a way to avoid the bandwidth bottleneck and build industrial cathode-ray-tube displays with a resolution of more than 4 million pixels. By sweeping a whole bundle of beams through a raster scan, it is possible to keep the screen refreshed without flicker and still address every point in a single scan.

First into the market with a direct-view multiple-beam product is Azuray Inc., a startup that has already found a medical-imaging customer for its 2,048-by-2,048-pixel CRT display. Azuray's 2000/BW provides "the missing link in radiology," according to Richard Rossalek, vice president of Matrix Instruments Inc., which has built the Azuray tube into a medical diagnostic system.

This high-resolution imaging system permits digitizing and consequent interactive analysis of X-ray films, Rossalek says. Until now, no CRT could provide film-quality resolution, and so conventional radiology has not been able to analyze data electronically.

Litton Electron Devices of Tempe, Ariz., a division of Litton Industries, already makes a multiple-beam tube for photographic analysis. This system is not suitable for direct viewing, though, because it displays information one sweep at a time and requires a moving film to build up a complete image. But Litton is also building a 12-beam direct-view tube.



PAINTBRUSH. All eight beams in the Azuray high-resolution display system are deflected in a bundle, so that they act as a kind of "brush" to paint the CRT screen eight lines at a time.

A prototype system will be ready within weeks, according to James Abendschan, manager of Litton's CRT group. He adds that Litton is negotiating with two "substantial" companies to incorporate the tube into high-resolution displays.

Azuray president William F. Fenley notes that displays of 2-K by 2-K or better are desirable for medical imaging, military intelligence, analysis of the earth's resources, and high-end computer-aided design and engineering. To refresh such displays, with up to 12 bits of digital-to-analog conversion for gray scale and color information, requires 300 MHz of video bandwidth, nearly twice the rate of current state-of-the-art video amplifiers.

The Azuray display provides 256 levels of gray scale. This month, the company will take the technology a step fur-

BANDWAGON ROLLS FOR LC SHUTTER

Azuray is one of the early adopters of the Tektronix liquid-crystal shutter as a color path, but is by no means the first. Several monitor manufacturers have already developed prototypes that use the shutter. Motorola Inc. and Dotronix Inc. of New Brighton, Minn., demonstrated the shutter on 15-in. professional color-graphics displays in July. Ball Electronics Systems division, of Westminster, Colo., showed a three-dimensional version last spring. And a Palo Alto, Calif., consultant, David Wilson, has mated the shutter to the Apple Macintosh. Tektronix itself has launched three products—an oscilloscope, a color display, and, at Siggraph last month, its 1241 logic analyzer.

Tektronix markets the shutter and its related products through a 40-person operation called the Liquid Crystal Shutter Strategic Business Unit. One function of this unit is to help customers integrate the shutter into their electronics, explains manager Michael G. Swink. The unit also sells products of its own, such as an emulator card that turns IBM Corp.'s Personal Computer into a high-resolution color display. The card has its own character generator that produces output at a 640-by-400-pixel resolution from the 640-by-200-pixel display IBM provides. Swink's unit offers the card alone or packaged in the PC.

The Tektronix shutter polarizes light from red and green filters to create color images from monochromatic light. Wilson notes that on the Macintosh, with its bluish display, color distinctions are limited. Swink claims the shutter can display a full range of colors, far more than the average viewer can discern, but adds that most users don't need or even want full color displays. Tektronix has held back on its plans to develop a three-filter version of the shutter, which would produce true colors, because it sees little demand for the product.

"The people we talk to don't need true color, they just need color," Swink says. "And typically, they don't need more than four to seven colors on the screen at once." Swink and Wilson agree that the biggest use for screen color is as a code. On its own instruments, for instance, Tektronix displays out-of-range values in red, and appropriate values in green. **–C. B.**

ther by mating it with Textronix Inc.'s liquid-crystal shutter to provide a 2-K-by-2-K-pixel color display.

Conventional shadow-masking techniques for generating color are running out of gas, says Roy E. Murphy, Azuray's vice president for research and development. These techniques involve firing electrons through holes at separate red, green, and blue phosphor dots, and the state of the art for holes in current shadow masks is about 0.21 mm. A 2-K-by-2-K-pixel display would require a hole size between 0.10 and 0.15 mm, which is so small that the mesh itself would be weakened and easily damaged by high beam currents.

Performing in parallel what can't be done serially is a time-honored way to breach technical barriers. But to make the multiple-beam technique work, Azuray spent three years developing the deflection circuitry to keep the beams synchronized. What finally made this circuitry possible was the availability of cheap memory and a powerful microprocessor: the Azuray system uses a Motorola 68000 and 8 megabytes of dynamic random-access memory to store and display images.

The multiple-beam technology itself had been developed by Rank Precision Industries Ltd. in the UK and used in a military reconnaissance system by Honeywell Inc. In this system, as in Litton's, a bundle of 12 beams oscillates in a single plane, forming an image on a strip of film that is moved across the faceplate of the CRT. In this case, the multiple beams record information from separate sensors.

BEAM GENERATION. Multiple beams are generated from a single source by pulling the electrons through an array of 0.001-in. holes, one hole for each beam, located in separate fingers in front of the cathode. The fingers are designed so that electrons that try to go around them, instead of through the holes, are blocked by other plates in a stack.

To obtain a multiple-beam raster-scan system, Azuray puts each finger under the control of a single video amplifier, which determines beam intensity by varying the potential on the finger. Once past this stage, the system behaves much like a conventional CRT, except that it uses a "brush" of eight beams to paint a picture on the tube, rather than a single beam. The eight analog signals are swept at 15 kHz at 60 frames/s, noninterlaced. The focus and deflection coils are standard high-definition TV components. Current display is on a 19-in. tube, with a 25-in. version to follow.

Litton's Abendschan cautions that the multiple-beam technology still has a long way to go before all its problems are solved. Both the tube itself and the control electronics are brand-new, he notes. He agrees that multiple-beam imaging offers a good solution to the problem of switching bandwidth, but adds that high-speed single-beam CRTs are also possible using gallium arsenide transistors.

The high-resolution Azuray display will not come cheap. An entry-level Azuray monochrome system sells for $35,000; no price tag has been set yet on the higher-priced color model.

Nevertheless, Azuray, a company of 25 employees that has spent most of its four-year lifetime developing the display with the help of privately obtained funds, remains confident. Murphy says that the company's system can support resolution even higher than 4-K by 4-K pixels. *–Clifford Barney*

MICROWAVE

FREQUENCY-DIVIDER IC RUNS AT 5 GHz

BOCHUM, WEST GERMANY

Using standard bipolar fabrication processes, a group of researchers at Ruhr University has developed a monolithic integrated microwave-frequency divider that boasts an operating range from 1.4 to 5.3 GHz and consumes as little as 135 mW. As far as the Ruhr researchers know, theirs is the first monolithic microwave-frequency divider thus fabricated that can handle input signals exceeding 5 GHz.

Up until now, practical microwave-frequency dividers working at 5 GHz and more could be made only with discrete devices or hybrid techniques, says Hans-Martin Rein, head of the university's research team in Bochum. Integrated versions, which are usually based on the master-slave D-flip-flop (MSDFF) principle and made with standard bipolar processes, attain frequencies only half as high—2.5 GHz.

Japanese researchers have reached about 6 GHz with integrated frequency dividers that are also based on MSDFF concepts using bipolar technology. But their experimental devices call for sophisticated processes involving, for example, super-self-alignment or sidewall-base contact, Rein says.

And in both Japan and the U. S., dividers working at or near 5.5 GHz have been fabricated using gallium arsenide. "But all these techniques are very complicated and use stripe widths of 1 μm and below," Rein notes.

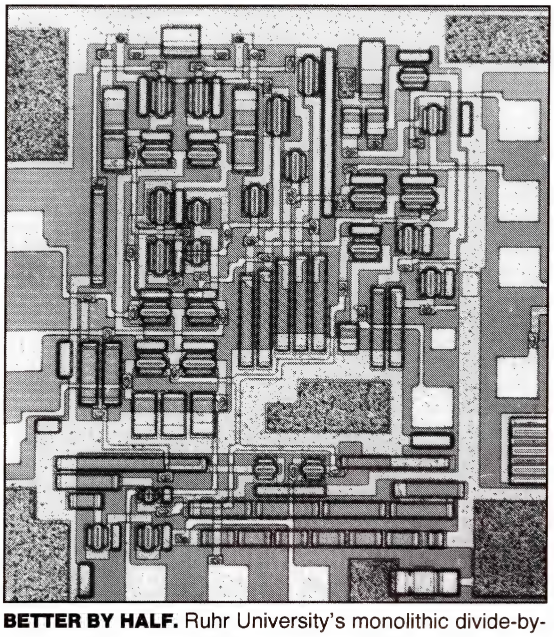
The high-speed Bochum divider, by contrast, can be fabricated with 2-μm processes that are common throughout the industry. In fact, as researcher Rainer Derksen will tell his audience this month at the European Solid State Circuits Conference in Toulouse, France, semiconductor maker Telefunken electronic GmbH already has fabricated samples of the integrated divider on standard production lines at its Heilbronn facilities.

After looking at various divider principles that promised high-frequency performance, Rein and his team concluded that regenerative frequency division, first described in 1939, would be best for monolithic integration. This technique has one major advantage over the more popular MSDFF approach: the maximum divider frequency is determined by the cutoff frequency of the closed mixing loop and not by the loop delay, as is the case with MSDFF.

Rein's group confirmed the expectations that this would lead to a higher operating frequency at reduced power dissipation, first by network simulations, and then by measuring the actual device. Later tests showed the maximum divider frequency to be double that of an integrated version based on the MSDFF scheme and using the same fabrication process.

The research team achieved 5.3 GHz at a supply voltage of only 5 V. At 5.5 V, the device can handle a somewhat higher frequency—5.6 GHz.

"If the market accepts the new device, we plan to bring out working samples in small quantities sometime this year," says Klaus Wörner, head of Telefunken's high-speed circuit-development



BETTER BY HALF. Ruhr University's monolithic divide-by-two divider stage and buffer measures 0.7 by 0.8 mm.

labs in Heilbronn. As possible applications, he points to communications systems, measuring equipment, and counters.

With its frequency exceeding 5 GHz, "the device is interesting, particularly as a prescaler in 4-GHz satellite communication systems being designed in the U. S.," Wörner declares. And because the divider makes use of standard fabrication techniques, the chip also promises to be relatively low in cost, but Wörner will not fix a price yet.

The Bochum team's chip is built around a regenerative divide-by-two stage. One of its mixer ports is fed with the input signal and the other port gets a feedback signal, half that of the input, from the output of the stage's amplifier. The mixer is a double-balanced modulator based on an emitter-coupled-logic series-gating technique.

The amplifier, a transimpedance type, is crucial to the circuit. Because of it, a low-pass filter function can be derived from the modulator's and amplifier's upper frequency limits. The circuit, including the reference-voltage network and the output buffer, needs only 24 transistors and 21 resistors. The chip measures 0.7 by 0.8 mm.

The chips are fabricated in a standard technology characterized by multiple-ion-implantation, arsenic-washed emitters, a 1.5-μm epitaxial layer, oxide-wall isolation, and a minimum stripe width of 2 μm. The shallow profiles of the emitter and base regions make for a transit frequency of 5.3 GHz at a collector-emitter voltage of 1 V.

CAREFUL DESIGN. The Bochum researchers credit the device's good results to its careful design and optimization. The transistors were individually sized with regard to maximum divider frequency. Emitter area was minimized so that at junction temperatures up to 90°C, quasi-saturation and high-current effects would not markedly degrade the maximum operating frequency.

Eventually, it should be possible to design microwave frequency dividers operating at above 10 GHz, Rein says. These would be based on modern silicon bipolar technologies like those used in laboratories today. *–John Gosch*

DATA COMMUNICATION

ALGORITHM TRIPLES DATA SENT OVER DIAL-UP LINES

SAN ANTONIO, TEXAS

A proprietary data-compression algorithm is the secret code in two new modems that their maker says can triple the effective throughput of highly redundant characters transmitted over standard dial-up telephone lines.

Data Race Inc., has come up with an adaptive-compression algorithm that makes it possible for the new San Antonio company's modem to offer high transmission speeds that would usually require expensive, conditioned, leased phone lines. The sending and receiving modems can recognize opportunities to reduce the number of bits sent over dial-up phone lines.

Fast modem compresses data on the fly

The modem is aimed at what the company believes is a growing data-processing need for low-cost, dial-up connections between dumb but fast interactive ASCII terminals, printers, and multiuser host computers. The unit is much more than an intelligent, high-speed modem, says Data Race. In fact, it is dubbed "Race" for remote asynchronous computer extension.

Of course, the compression of data bits to speed up transmission throughput is not a new technique. But earlier schemes have used compression algorithms that were tightly tailored to specific hardware and were most often used over dedicated transmission lines. Data Race's software compresses data on the fly. If data contain repeated strings of characters, the modems will quickly agree upon abbreviated transmissions representing the repetitious block.

"We are using string compression, character substitution, and repeated-group substitution. The system will automatically substitute a shorter symbol for what is actually being transmitted," explains L. E. (Les) Staples, vice president of development and a former senior engineer at Datapoint. "Repeated characters are the simplest for where a string of spaces or dots might be sent as a couple of characters. We actually compress characters themselves as well."

The Race modem is available in two versions. Race-I is a single-channel full-duplex modem, which sells for $1,995. Race-II, which sells for $2,495, has a second independent printer channel, which is statistically multiplexed with the main video-display-terminal channel. The second channel allows users to simultaneously print and use a keyboard terminal over the same phone line. Along with conventional modem functions, the units also provide automatic dialing, a 300-b/s mode for Bell-103-compatible transmission, programmable hangup, and half-speed modulation whenever the quality of the phone line results in unacceptable bit-error rates.

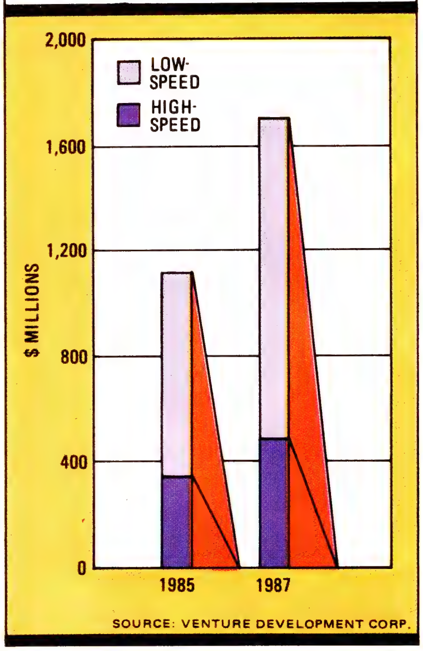
ADAPTIVE. The error-correcting modems use a combination of signal-processing techniques for adaptive line equalization to cover a wide variety of conditions over the public phone network and include a noise-filtering feature. The user can select data rates to match terminal and computer-port speed ranging from 1,200 to 19.2 kb/s.

The two-year-old startup, which is led by former Datapoint vice president Herb Hensley, believes the falling prices of large multiuser computers are creating a resurgence in remote interactive terminal use. In most long-distance applications, high-speed interactive terminals are connected to hosts over leased lines, which now cost $1.50 per mile per month, plus hefty installation charges. High-speed, dial-up modems would allow users of interactive terminals to make connections over the public phone network at a much lower cost.

Data Race and other modem makers are chasing an emerging new segment of high-speed data-communications market, which Venture Development Corp. of Natick, Mass. estimates at $346 million of a total $1.1 billion U. S. business in 1985. High-speed modems—with speeds over 4,800 b/s—will increase to $497 million of a total $1.7 billion market in 1987, says William C. Garrett, communications industry analyst with Venture Development (see chart).

"When you are talking about dial-up

SALES OF MODEMS SURGE



SOURCE: VENTURE DEVELOPMENT CORP.

modems, you are usually talking about an under-1,200-b/s rate. Some 2,400-b/s systems have error-correction built in, but when you get much higher, it's a different ball game," Garrett adds.

STRIPPED DOWN. The Data Race data-compression scheme will start off by stripping 20% to 30% of the bits typically used to move data, such as stop/start bits and parity checking. Once that is accomplished, the Zilog Inc. Z-80-based modem will quickly look for additional bit savings by compressing any redundant string of characters, such as spaces, dots or lines.

Terminal users can employ dial-up links

When the compressed data is received by a Race modem on the other end of the link, the characters will be quickly reconstructed and sent on to the standard computer port on the attached host or peripheral. A string of dots on a terminal screen, for example, will be transmitted as simply a pair of characters over the line.

Display screens of data containing no compressible redundant character strings can be transmitted over Race modems at a rate of 650 c/s. Highly compressed data will fly through the units at speeds over 1,800 c/s. "Typical data-processing text, which often contains a lot of spaces, columns, and so forth, will travel at 1,000 c/s with no errors over the standard dial-up phone lines," says Staples. "Typical word-processing applications, which are only about 15% compressible because of random word usage, will see rates of 750 c/s." Data Race is applying for a patent on its data-compression technique.

The modem's compression engine is made up of the 8-bit Z-80 host and a collection of CMOS digital signal-processing circuits. Data Race officials decline to identify the semiconductor company that makes the DSP chips, saying only that the components are proprietary to another electronics supplier.

The CMOS Z-80 host microprocessor takes care of compression and decompression at the character level. Software for the character-recognition and compression algorithm resides in read-only memory. While the data is being worked on by the compression scheme and error-correction software, the modem holds it in an 8-K block of battery-backed CMOS static random-access memory. *–J. Robert Lineback*

PATENT LAW

DEC's LAWSUIT REOPENS PLUG-COMPATIBILITY ISSUE

LOS ANGELES

Digital Equipment Corp.'s recent moves against unlicensed suppliers of add-on hardware for its equipment are raising legal questions about plug-compatible relationships that most of the industry had considered long dead.

DEC filed suit in early July against Emulex Corp., alleging patent infringements by the maker of controllers and mass-storage and communication products for DEC computers. Nonetheless, the Costa Mesa, Calif., company has gone on to announce a stream of DEC-compatible products. Emulex and others say DEC is simply using a flurry of lawsuits to discourage competition now that business is suffering.

But suppliers of plug-compatible peripherals and subsystem add-ons for popular computers walk a narrow line. For the most part, add-on makers proceed without a formal licensing agreement. As long as their equipment enhances a computer's performance—and therefore its sales potential—the computer manufacturer usually sees plug-compatibility as a plus.

The classic example is IBM Corp.'s Personal Computer. The PC's runaway success is largely due to the company's policy of opening its architecture to all suppliers. A secure niche for plug-compatible firms thus seemed confirmed by market action, according to most industry consultants.

In its July action, DEC asked for an injunction barring Emulex from selling disk controllers that use DEC's patented Mass Storage Controller Protocol or plug into its patented buses for VAX, Microvax, and PDP-11 computers. With some $76 million of annual sales from the products in question, amounting to 75% of its 1985 revenues, Emulex is the largest supplier of DEC-related plug-ins.

Did DEC sue to stifle its competitors?

A similar suit, filed in 1980 by DEC against System Industries Inc., Milpitas, Calif., has been scheduled for a February 1986 trial in U. S. District Court in Massachusetts. Many observers considered this suit a dead issue after five years, in light of the IBM PC development. But a spokesman for DEC says during the interim, continuing efforts to settle it out of court came to naught.

DEC says the recent flurry of activity represents no change but "demonstrates the company's long-standing policy and commitment to protect vigorously its innovations." A representative points out that several other suits underscore the continuity of the policy. Last December, DEC sued C. Itoh Electronics Inc., Los Angeles, over alleged infringement of patents on the VT-220 terminal. In May, a similar suit was filed against EMC Corp., Natick, Mass., over a controller for memory boards.

DAMPER. But industry observers believe the suits stem more from business conditions than policy. According to this view, sluggish demand precludes much growth for the time being in DEC's computer lines, making a stepped-up campaign to sell its own enhancements more attractive. "They [DEC] are trying to diversify into the storage areas, and this is a way to limit competition," states Vipul Mehta, who edits a newsletter called "Peripheral Concepts" in Irvine, Calif. "Suing the No. 1 compatible supplier dampens competition."

Emulex officials endorse this opinion. "They're trying to monopolize the marketplace and keep the customers for themselves," says Michael J. Lewis, vice president for finance. Emulex also doubts that the DEC patents are enforceable, and "we don't believe they will withstand the scrutiny of the courts." Lewis points out that even if the DEC patents proved enforceable, "our technology neither copies them or picks up any part."

Emulex has not altered its strategy, and has steadily brought out new DEC-compatible products since the suit was filed. In the offing is an enhancement for the Microvax that boosts the number of potential users to 144 from a total of 48 possible now.

In the short run, some industry officials believe DEC could be hurting its own position by trying to inhibit suppliers who offer higher-performance plug-ins. "There's just not enough support on the inside for [all of] DEC's products," notes Mehta. "A lot of their past growth was due to the variety of support from outside."

Though the targets of DEC's plug-compatible suits play them down and go about business as usual, the legal actions could eventually have wide significance. Although it would take years for the cases to go through the courts to a final decision, they could be important in clarifying patent law as it relates to plug-compatibility. For the Emulex suit, in particular, "all the ingredients seem to be there for a landmark case," observes Thomas Skornia, a lawyer in Los Altos, Calif., who specializes in high-tech law. *–Larry Waller*

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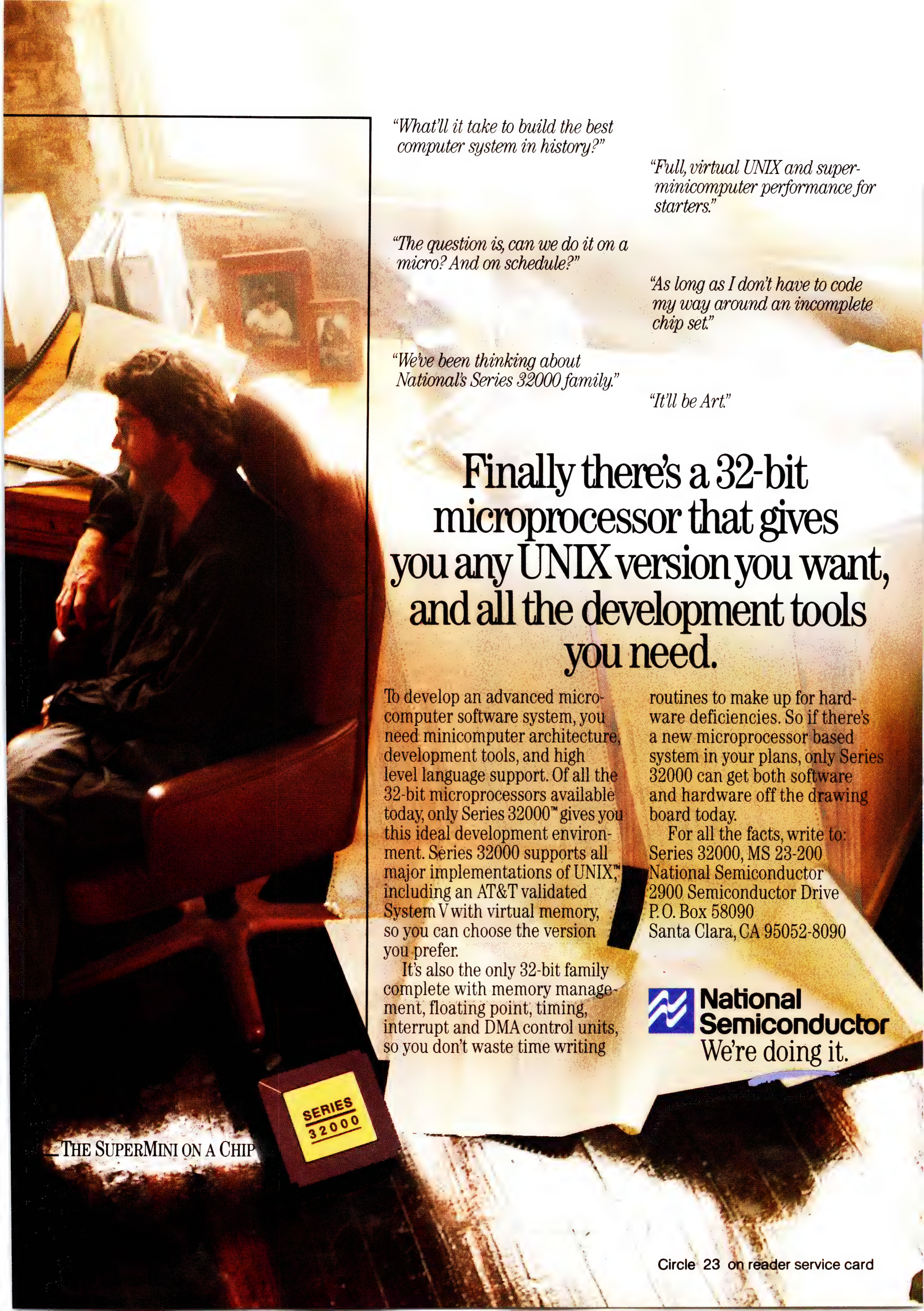

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THIS ELECTRONICS WEEK

JAPANESE IC SALES TO U. S. DROP 20%

Japanese exports of integrated circuits to the U. S. have fallen 20.3% in the first seven months of 1985, according to Japan's Ministry of Finance. By year end, Japanese industry sources predict, total IC exports will be off 20%, with exports to the U. S. down 40% from 1984's total of $1.57 billion.

BIG JUMP FORESEEN IN GaAs SALES

In what is probably the most optimistic forecast made during the current industry slowdown, a study by Electronic Trend Publications predicts the gallium arsenide market will skyrocket from $60 million this year to $1.8 billion by 1990. Although the study admits manufacturers of GaAs semiconductors still face difficult technology hurdles—specifically in chip testing and packaging—it expects advances in materials technology and in crystal growth to continue improving yield. This will then result in greater numbers of new GaAs logic circuits and sophisticated analog GaAs ICs introduced to replace discrete devices. The expected growth area is in communications, which the study says will command 35% of the market. The big change will be in defense applications: the military's 76% share should drop to 30% by 1990.

MITI SUSPENDS FIRM FOR HUNGARY SALE

A Japanese trading company has been forced to suspend business operations for one month because it illegally exported semiconductor-manufacturing equipment to an Eastern Bloc country. Kurimoto Trading Co., Tokyo, is the first company to be punished by Japan's Ministry of International Trade and Industry for violations of Coordinating Committee for Export to Communist Areas (Cocom) regulations. The company allegedly allowed a Hungarian diplomat to smuggle a U. S.-made integrated-circuit-design system in a cargo container sent from Tokyo to Hungary last December. Japan is one of 15 nations that have signed the Cocom agreement, which bans the export of 164 types of high-tech goods to communist-bloc nations.

THREE IN EUROPE START ASIC MAKER

Look for the announcement early next month of a new European company that specializes in application-specific integrated circuits. Called Silicon Structures, the company was created by Jean-Luc Grand-Clément, who was formerly the managing director of Eurotechnique; Robert Heikes, formerly vice president of European operations for National Semiconductor Corp.; and Robb Wilmot, president and chief executive officer of International Computers Ltd. Silicon Structures intends to produce its chips using electron-beam technology. It will have its headquarters in Luxembourg.

STUDY: ROBOTS TO ROIL WORKPLACE

Robots will have an increasingly disruptive effect on the work force over the next decade, according to a study released by the Society of Manufacturing Engineers and the University of Michigan. The study predicts that 4% of the work force will be displaced throughout industry. At the same time, robotics will create about 50,000 jobs. Annual sales of robots are expected to increase from the current 5,000 units to 10,000 by 1990, and to 20,000 by the year 2000. Occupations most affected by robot installations will include production painters, welders and flamecutters, machinists and machine operators, and assembly-line workers. Displacement in the electronics industry will rise from 3% this year to 15% by 1995. The study also predicts that 73% of workers who quit or are laid off will find new jobs within a year.

ATARI GAMES WILL BE BUILT IN MEXICO

Atari video games smuggled into Mexico from the U. S. will get some legal competition from Gradiente Eletronica Ltda., the Atari license holder in Brazil. The consumer-electronics manufacturer will produce and sell the games in Mexico starting in October. The company will manufacture 25,000 players and 180,000 game cassettes this year and expects sales of $5 million, representing some 25% of its total sales. For 1986, it expects that sales of the sets will double. The company says the sets, which will be sold with five games, will retail for $170 in Mexico and have the advantage of carrying the manufacturer's guarantee.

AT&T'S PC GETTING IBM COMPATIBILITY

Alloy Computer Products Inc., Framingham, Mass., has granted AT&T Co.'s Information Systems Division exclusive rights to market Alloy's DOS-73 add-in board for the AT&T Unix PC. With the board, the Unix PC can run a variety of application-software packages designed for IBM Corp.'s Personal Computer, Alloy says. The agreement, according to Alloy, will offer AT&T "increased penetration of the Fortune 500 market and other major accounts that have invested in software for the IBM PC and compatibles."

INFERENCE AND SRI SIGN AI DEAL

In a move to more quickly pull expert-system artificial-intelligence technology into commercial use, Inference Corp., Los Angeles, and SRI International, Menlo Park, Calif., have formed a consulting partnership. The agreement will provide consulting and training for SRI customers and prospects in the use of Inference's Automated Reasoning Tool expert-system technology. It will ease technology transfer—one of the problems preventing more widespread use of expert systems. The system is designed to enable programmers without extensive AI background to develop commercial expert systems.

UNUSED COMPUTER: MOST POPULAR?

The credenza computer—the machine that sits untouched on a credenza behind an executive's desk—has become the most popular computer today. So says Ronald LeBleu, a New Haven, Conn., human-relations consultant. "At least the credenza computer has the appearance of being used. It may display—permanently—the same four-color chart." LeBleu, a partner in Software People Concepts Inc., maintains that "regardless of brand name, software that's user-friendly, or corporate edict, many executives do not have the need or desire, time or patience to use the PCs." They are "a vivid symbol of misdirected technology," he says.

DATA DESIGN, ADR IN MARKETING PACT

Data Design Associates Inc., Sunnyvale, Calif., and Applied Data Research Inc., Princeton, N. J., have just entered into a joint-development agreement under which Data Design's line of mainframe-based financial software will operate in conjunction with Applied Data's Datacom/DB relational-data-base management system. The plan calls for joint development of all Data Design business-application systems to operate under Datacom/DB.

INTEL JUMPS HEADLONG INTO THE MAP BUSINESS

COMMUNICATIONS MODULE MEETS FACTORY-AUTOMATION STANDARD

by David M. Weber

SANTA CLARA, CALIF.

The much-discussed Manufacturing Automation Protocol, championed by General Motors Corp. since 1982 to connect dissimilar hardware in the factory, is finally beginning to spawn products. And in the forefront of a growing band of suppliers is Intel Corp. Because it expects MAP to dominate data transfer on the factory floor, the Santa Clara chip maker is about to begin a major assault on the market with a broad line of MAP products.

Intel is making its initial foray with a board-level interface, the first in a family of communication modules built of very-large-scale integrated circuits. It soon plans to introduce systems-level communicatons hardware with more memory to link entire computer-integrated manufacturing cells.

Intel does not plan to offer end-user packages because the requirements for such packages vary from application to application. The original-equipment manufacturer must write software to implement MAP for each task.

RELUCTANT. Until recently, potential MAP vendors were reluctant to rush to market with communications hardware because of the difficulty in designing products that can fulfill the varied requirements of the multitiered MAP system and the prohibitive cost of the associated protocol interpreters.

At the factory-floor level of MAP, for example, such equipment as motors, solenoids, and relays must be controlled in real time—requiring short, fast messages. But at the top level, where the factory managers analyze overall performance of an automated operation, real-time control is less important than detailed information about whether the factory is meeting its production commitments and product-quality standards.

The middle levels govern instructions to robotic work cells or numerical controllers. These tiers require communications that can transfer data for both real-time control and for the tactical, hour-to-hour coordination among the various elements in a manufacturing process.

IN CONTROL. Intel Corp.'s new communications gear for the Manufacturing Automation Protocol permits different machines to tie into a single control protocol.

Intel claims to have met this challenge by applying VLSI architecture to the problem of real-time data transfer. The company is introducing the board-level iSXM 554 MAP COMMengine. The board is built around Intel's Multibus I architecture and satisfies MAP specifications for industrial local-area networks.

The iSXM 554, aimed at original-equipment manufacturers that supply products for industrial automation, will sell for $3,750. It aims to ease communication among programmable controllers, robot work cells, vision systems, and automatic guided vehicles—all of which will be tied together by MAP local nets. "This new communication board provides OEMs with complete hardware MAP compatibility, reducing the time it takes to meet MAP specifications," says Bill Lattin, vice president of Intel's Systems Group in Hillsboro, Ore. "OEMs already designing with the Multibus architecture can meet MAP compatibility by simply adding our 554."

Intel's communications board consists of a single Multibus controller, conditioned for use on the factory floor, that can accept a direct connection from a MAP local net, eliminating the need for an intermediate protocol converter.

The heart of the 554 board is an 80186 microprocessor that controls 256-K bytes of random-access memory to run MAP communications software. The board has two custom protocol chips that implement token passing and can fit up to four erasable programmable read-only-memory chips for storage of up to 128-K bytes. Two socketed EPROMs store station-management and configuration parameters. A 24-bit master/slave interface connects the board to the factory. An SBX connector facilitates expansion of the system.

The 554 board is not intended to tie machines together at the systems level, emphasizes Michelle Ryder, Intel's manager for MAP products. "We're concentrating on supplying board-level equipment to any OEM whose customers in the factory use IEEE 796-compatible Multibus backplanes," she says. "In purely physical terms, we tie in with any one of three 12-MHz channels in MAP's 400-MHz-broadband coax LAN."

To implement communications with the outside world—and to clear a path for integration into systems-level control—Intel's new board has a LAN-ready radio-frequency modem that transmits data at an Ethernet-compatible 10 Mb/s and includes a copy of Intel's iNA 961 transport-layer software.

Such integration of software with MAP local-net hardware is similar to the approach that General Electric Co. and Ungermann-Bass Inc. worked out last year [*ElectronicsWeek*, Sept. 17, 1984, p. 32]. Under their agreement, GE's protocols for a MAP interface are written into the token-passing hardware of Ungermann-Bass controllers and manufactured as a separate networking product by Industrial Networking Inc., Intel's neighbor in Santa Clara.

Intel, too, is calling upon the expertise of an industrial company to develop MAP hardware. In a cooperative venture with Westinghouse Electric Corp., Pittsburgh, Intel is developing a communications interface preconfigured for the iSXM 554 board and designed to meet the specifications for the upper three levels of the MAP model.

But this agreement does not portend an Intel-Westinghouse move into applications. That area will remain in the hands of the OEMs.

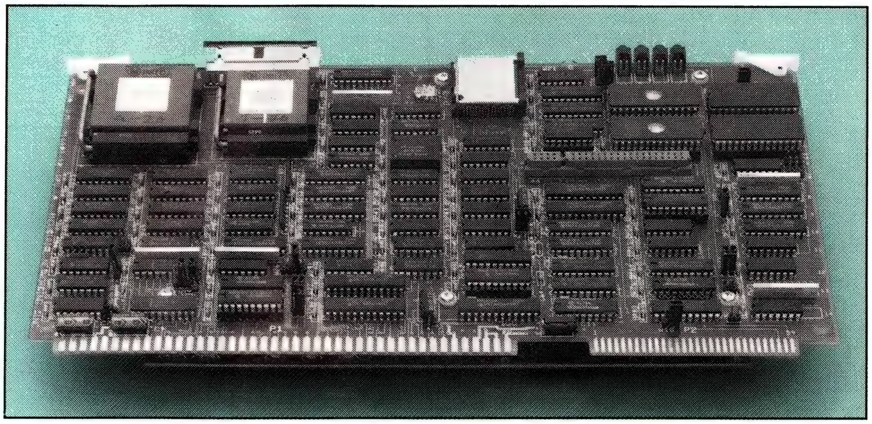
"Our communications products [for factory automation], and any expansion of their capabilities, will remain just that—designed to hook other systems into MAP," says Ryder. "We'll supply the interfaces to get something like a robot or machine-vision system into the [MAP] network, but the OEM is the one who has to write the applications software to make a specific automation system work."

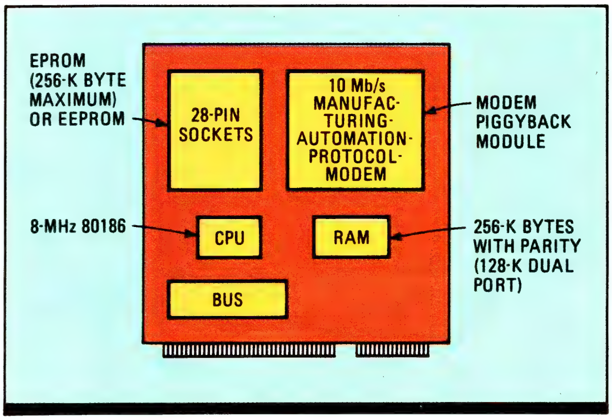
That approach handles the problem that every production line is different, and it is nearly impossible to write a general software package for more than one automated process. Dennis Lockhart, project manager for factory automation systems at Universal Instruments Corp., Binghamton, N. Y., says, "The best approach is to configure a system piece by piece and write the software as you go."

Indeed, Lockhart is also wary of inventory-control protocols such as MRP II [*ElectronicsWeek*, Oct. 15, 1984, p. 20], preferring instead to customize the materials-handling procedures of Universal's automated-assembly equipment to the stated requirements of a given customer. Such an approach differs sharply from that of some computer-oriented companies that claim to offer single-package software solutions for many plant-management tasks.

It is difficult to develop process-control software, even for a single company, emphasizes Vernon Estes, manager of GE's product planning and market development in Orlando, Fla. "At GE, some of our divisions want to make dishwashers and others want to make jet engines. We can develop the software to run each plant," explains Estes. "But it's not going to be the same for both." Providing real-time control for a number of different processes, even within one plant, is beyond the scope of those who purport to write general software packages for the factory, he says.

As a result, GE and other leaders in the factory-automation business, such as Gould and Honeywell Inc., have devoted substantial resources to software engineering—often amounting to well over half the cost of an automation project. Estes warns plant managers to be wary of cheap solutions. "Anyone who says he's got off-the-shelf software for real-time control is fooling you. If you want to run a robot or a pick-and-place machine, you've got to be willing to spend the money and time to write the software for every application you have in mind."





BOARD LEVEL. Intel's iSXM 554 board provides MAP-interface communications at 10 Mb/s. VLSI Multibus architecture permits flexible real-time control of manufacturing equipment.

SYSTEMS LEVEL. Intel has recognized the complexity and diversity of the automation market and concentrates its efforts on factory LAN communications rather than control software. So the next step in Intel's MAP-oriented plans is a systems-level box, as Ryder describes it, that incorporates the memory and connection functions to run an entire work cell in a computer-integrated manufacturing scheme.

The box will be available to OEMs next year, but no date has been set. The hardware will be built around an Intel 86/310 microcontroller—part of Intel's Opennet product category, Ryder says. The configuration presumably means that it will be used within networks incorporating diverse applications—for example, CIM cells performing different tasks in an automated factory.

A systems-level controller focuses on the middle levels of the MAP protocol, where the coordination of different machines is more important than the real-time control of a single process. As a result, the upcoming Intel box will have hard-disk memory storage rather than the 2-megabyte iSBC 264 bubble memory that Intel is promoting for the lower levels of MAP.

OEMs can also configure their machines with non-Intel hardware because Opennet supports dissimilar operating systems, Ryder points out. Such flexibility is vital in the CIM market, with its variety of proprietary protocols.

The market for MAP-interface boards is expected to reach $1 billion by 1990—pushed by joint ventures between industrial and computer companies, says C. Kenneth Miller, president of Concord Data Systems, Waltham, Mass. Concord has teamed with Gould AMI to produce a three-chip VLSI board for MAP applications—for data, protocol, and direct-memory access.

It also gives potential buyers the choice of customizing the VLSI design. Under Intel's approach, the user customizes the applications software. "Hardware customization lengthens the development cycle, but it results in more powerful token-bus implementations," says Miller. Concord Data's first MAP products are expected by the middle of next year. ☐

'AMERICA FIRST' RULES IN U. S., SAY FOREIGN EXPORTERS

SOME FIND U. S. ERECTS TRADE BARRIERS OF ITS OWN

by Jesse J. Leaf

NEW YORK

While Congress and American protectionists protest long and loud about unfair trade practices in overseas markets, electronics companies in other countries counter that the U. S. is not above playing the same game itself. To many foreign eyes, the U. S. presents a hostile face to those electronics companies that attempt to do business on its soil. They run into confusing government regulations that seem to change constantly, labor problems, the ever-present threat of legal actions, and language and cultural hurdles. Executives who were polled by *Electronics* in Japan, Europe, and the Middle East agree that the U. S. suffers from its own brand of business chauvinism. "Americans want to do business with Americans—not because they are chauvinists, but purely for business reasons," says Zohar Zisapel, managing director of Rad Data Communications Ltd., an Israeli data-communications manufacturer.

Some of these reasons are understandable, says Zisapel: Americans believe that business is conducted faster, less expensively, and with fewer misunderstandings when the other company is fully conversant with local laws. Nevertheless, this puts foreign concerns at a disadvantage.

Some barriers are not openly discussed but are privately acknowledged. Several foreign executives believe that Americans are uncomfortable with someone who does not speak colloquial English and sometimes noticeably retreat into "inflexibility" during meetings, apparently because they think that an accent telegraphs deviousness.

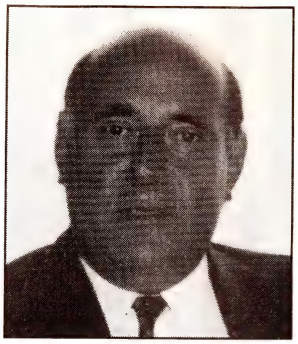
In Great Britain, for instance, industry observers have questioned the ability of the Apricot personal computer to make it in the U. S. because, they say, the company is just not professional enough to learn to "talk American." They have also criticized its sales literature and advertising as not being sufficiently "Americanized."

Sometimes even Americanization won't work. Take Ing. C. Olivetti & C. Perhaps the most successful native European player in the office-automation and data-processing fields, it had to enlist AT&T Co. as a U. S. big brother to distribute Olivetti personal computers to give it a foothold in the U. S. Olivetti chairman Carlo de Benedetti's previous five-year strategy, which he dubbed "being American in America," included the purchase of U. S. companies ranging from very small venture capital companies to Dallas-based Docutel Corp., which now trades under the name of Docutel-Olivetti. But all this was to no avail: the Italian company's market penetration at the end of the program was insignificant.

Then there are the lawyers. At Sumitomo Corp., a leading general trading company in Japan, an executive in the Electronics Export Section says that "recently, all sorts of legalistic barriers are appearing."

The Japanese are particularly sensitive to the growing number of cases being brought before the International Trade Commission, especially concerning charges of dumping. They are critical of the litigious instincts of U. S. companies, which are harming trade "by running to the ITC at the drop of a low-priced product," according to the Sumitomo executive.

MANY APPROVALS. Companies abroad find still more barriers to overcome when attempting to deal with the free-trading U. S. The need for Underwriters Laboratories and Federal Communications Commission approval labels on relevant equipment can be a significant problem. Although such approvals often are not required legally, as a practical matter companies say they are needed to expedite sales. "It is more difficult for overseas manufacturers to sell without approval, which is a form of discrimination," maintains Mitsuhiko Ya-



SEARCHING. Thomson's Carlo Zanni discovered that finding U. S. talent is difficult.

HURDLES. The U. S. tends to set up too many legal barriers to trade, says Mitsuhiko Yamada of the Nikko Research Center Ltd.

DISADVANTAGE. Zohar Zisapel finds Americans uncomfortable dealing with foreigners.

mada, director for international research at the Nikko Research Center Ltd.

Obtaining the necessary product approval takes time, whether it is done overseas or in the U. S. Either way may take several months and thousands of dollars. This makes the approvals a substantial barrier for small companies selling in small quantities or a company selling many different products.

Bureaucratic delay in granting export licenses to foreign companies is also regularly cited by executives who want to sell in the U. S. "I can see the need for regulation, but the U. S. regulates unnecessary products," complains Yamada. "The Ministry of International Trade and Industry also requires papers for many exports, but the three or four weeks required in the U. S. is too long. We lose our chance to make a sale."

Historically, companies wishing to tap the U. S. cornucopia have sought a distributor to hawk their wares on Yankee soil. The results are not always satisfactory. Unlike in Europe, where distributors act as extensions of companies, foreign companies discovered that few U. S. distributors offer technical support. "They sell, but for technical support they would send the customer to the company," says Zisapel of Rad Data Communications. "If you're a company in Israel, you have a problem."

ENTRY POINT. Overseas companies quickly discover one secret to cracking the U. S. market. "You must have a base in the U. S.," says Menachem Reshef, vice president of planning and production at SES Ltd., an Israeli manufacturer of computerized industrial systems. "It is the one question every [American] asks. Nobody wants to do business with you if you don't."

But even companies with a U. S. base discover that America's attraction as a market is also its problem. Foreign electronics executives say the country's sheer magnitude means a sizeable investment is necessary to have an impact—a prohibitive outlay for some companies, yet holding no guarantees even for those giant corporations willing to hang the expense.

For example, "the U. S. requires a tremendous investment in advertising," says Zisapel. "So much more than any other country, the U. S. is saturated by mass advertising. If you want to be felt in the market, there is a certain threshold you have to advertise above. That is quite a heavy burden."

Even companies the size of France's Thomson SA—with sales of more than $6 billion per year—find the bill for a U. S. presence is too big. Though Thomson—along with Philips, one of the two most important European producers of consumer electronics goods—would like to attack the U. S. consumer market, it simply can't afford to establish or buy an existing U. S.-based company of sufficient size to give the French company a significant presence.

But the classic example of exclusionary U. S. trade policy is in the defense sector. British companies, for example, have long complained of the huge imbalance in arms trade between Europe and the U. S., a long-simmering feud exacerbated by the upcoming Strategic Defense Initiative program. Many Europeans believe that they will be excluded from all but the research phase. A high-level British team headed by Prime Minister Margaret Thatcher was awarded a cool reception when it visited Washington last month, canvassing for up to $1 billion of Star Wars business.

DEFENSE HURDLES. Non-U. S. companies come up against two roadblocks in this sector. The first is a powerful defense lobby consisting of both industrial producers and the military, which at every turn and congressional hearing cites the second obstacle—national security. This last issue is becoming increasingly important as the U. S. tightens the screws on what technology it will make available and what it will allow to be resold to the Eastern Bloc. The military is naturally unwilling to place strategically important defense contracts overseas and far from controlling hands.

There is also a belief among foreign companies that U. S. defense contractors have an in with the military. Should a U. S. company lose in a contract bid, it will still have points in the bank for the next round of contract offers.

Most foreigners understand U. S. sensitivity to the sales of defense electronics equipment to potential enemies. But sometimes, they say, U. S. authorities tend to be overcautious, and the result is that they only hurt themselves. One example is cited by Veronika Daisenberger, president of the Munich consulting company Service Agency Special [*ElectronicsWeek*, April 29, 1985, p. 46], which advises U. S. electronics concerns doing business in West Germany.

A German company had been making high-quality glass for electrical applications under license to a U. S. company and selling the products to countries in Eastern Europe. Since there was no restriction on exporting them, the German company entered binding delivery contracts with a Czech trading organization. In a sudden switch of policy, U. S. authorities barred such sales to Czechoslovakia on the grounds that they jeopardized U. S. security. The German concern vowed never again to apply for a U. S. license.

LABOR PAINS. The habits of U. S. workers are another sticky question for foreign companies wishing to establish a base here. "It's very difficult competing in the U. S. for a European company, and the reason is basically one of talent," explains Carlo Zanni, Thomson Semiconducteurs' sales director. "To attract really quality people, you have to be known and respected. Otherwise, the best sales engineers will either hold a top job with a company like Motorola or National, or they'll work for far less in a Silicon Valley startup, hoping to hit the jackpot and get rich. We've been quite successful in attracting good talent lately, but it isn't easy."

Nikko's Yamada says that labor turnover in the U. S., ranging from about 2% to 11%, tends to be excessive by Japanese standards. Workers will think nothing of quitting their job and shifting to another plant with a slightly higher hourly wage. This makes it extremely difficult to build up a reasonable skill level among the workers, he says. ☐

Reporting was also contributed by Robert T. Gallagher, Charles L. Cohen, John Gosch, and Kevin Smith.

DESKTOP PUBLISHING COULD BE BIG BUSINESS

IT COULD PROPEL THE NEXT SALES BOOM IN PERSONAL COMPUTERS

by Craig D. Rose

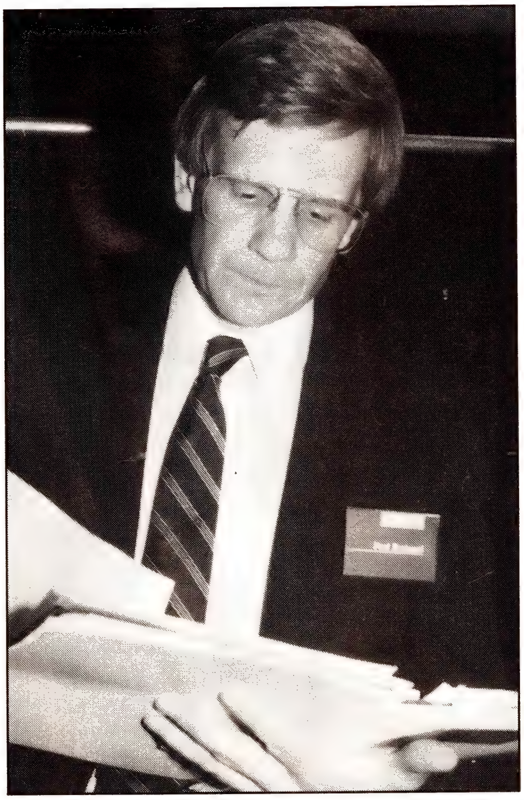
BOSTON

The tremendous popularity of electronic spreadsheets—software packages so popular that they singlehandedly sell the hardware—has had the personal computer industry eagerly awaiting the next big seller. The followup hit may come from desktop publishing.

Intended to be used on personal computers linked with laser printers, these software packages from a variety of companies are just beginning to come on the market. Early reaction indicates there is a large market for products positioned between word processors and more expensive dedicated publishing systems. For example, Aldus Corp., Seattle, reports receiving 1,000 inquiries per week for its Pagemaker software, which it announced in July. Manhattan Graphics in New York, which markets a similar product, Readysetgo, reports more than 1,000 inquiries a week and says it shipped 6,000 units since it introduced Readysetgo six months ago.

Interconsult Inc., a Cambridge, Mass., consulting company that specializes in the electronic-publishing area, estimates that the market will grow to $12 billion by 1988, from $2.6 billion; personal computer systems will account for half the revenue, with word processors and dedicated work-station-based systems taking the other half. "This may be the next Lotus 1-2-3 because it is the first thing you can do with personal computers that you can really save money with," says David H. Goodstein, president of Interconsult.

INCREASED PRODUCTIVITY. The lure of increased publishing productivity for corporations should be irresistible. Goodstein estimates that companies spend 6% to 10% of their annual gross revenue on corporate publishing and that much of this work, especially such shorter in-house documents as newsletters and pamphlets, can be produced at a significant saving using personal computers. Paul Brainerd, president of Aldus, says that 80% of corporate publishing needs can be satisfied by a personal computer-based system.



HOT. Aldus Corp.'s Paul Brainerd reports 1,000 inquiries a week for his company's desktop-publishing software.

David Wilson, manager of product research at Future Computing Inc., Dallas, traces the current market interest to Apple Computer Inc.'s introduction earlier this year of its Laserwriter. Coupled with a beefed-up Macintosh computer and one of the new software packages, the system provides a means of merging text and graphics, controlling layout, and selecting typefaces or sizes, without tedious cut-and-paste procedures or outside typesetting.

Other systems provide similar performance, and Apple was not the first to offer a laser printer—though it did improve on the price/performance ratio. The Cupertino, Calif., computer maker's biggest contribution, says Wilson, is that it is a high-visibility company in the retail market.

The Macintosh's graphics-production capability is another attraction for software developers. In addition to Aldus and Manhattan Graphics, Boston Software Publishers Inc. of Boston, and Microsoft Corp. of Bellevue, Wash., also market publishing software for the Macintosh.

Goodstein believes that the Macintosh's applicability for desktop publishing is more a happy accident than a planned application. In fact, had all the recent publishing packages been available at the time of the Macintosh's introduction, the computer would have enjoyed much higher sales, he says. Apple itself has recognized the market's potential and this spring created the new position of marketing manager for desktop publishing.

Publishing may be Apple's best shot at breaking into the office environment, something it has been trying hard to do. George Colony, president of Forrester Research, Cambridge, Mass., says that Macintosh-based systems will take market share from dedicated systems among smaller businesses and in-house publishing operations.

The Macintosh coupled with Laserwriter is a fairly sophisticated system, but still not equal to a dedicated 32-bit work-station-based system, says Colony. "But for a company doing forms and invoices, you don't need such a powerful system," he says.

Other software developers are basing their products on IBM Corp.'s Personal Computers, despite that machine's limited graphics capability. Mike Podanofsky, president of Modtek Inc., Lowell, Mass., says his customers tend to be familiar with typesetting and are willing to forgo visual capability for increased performance and specialized editing functions. "We have a good product for professionals," says Podanofsky.

Corporate Data Sciences Inc., Santa Clara, Calif., also uses IBM PCs as bases for its publishing package. Linda Kazares, director of sales, reports a 30% to 75% monthly increase in sales. Only 5% of publishing applications require

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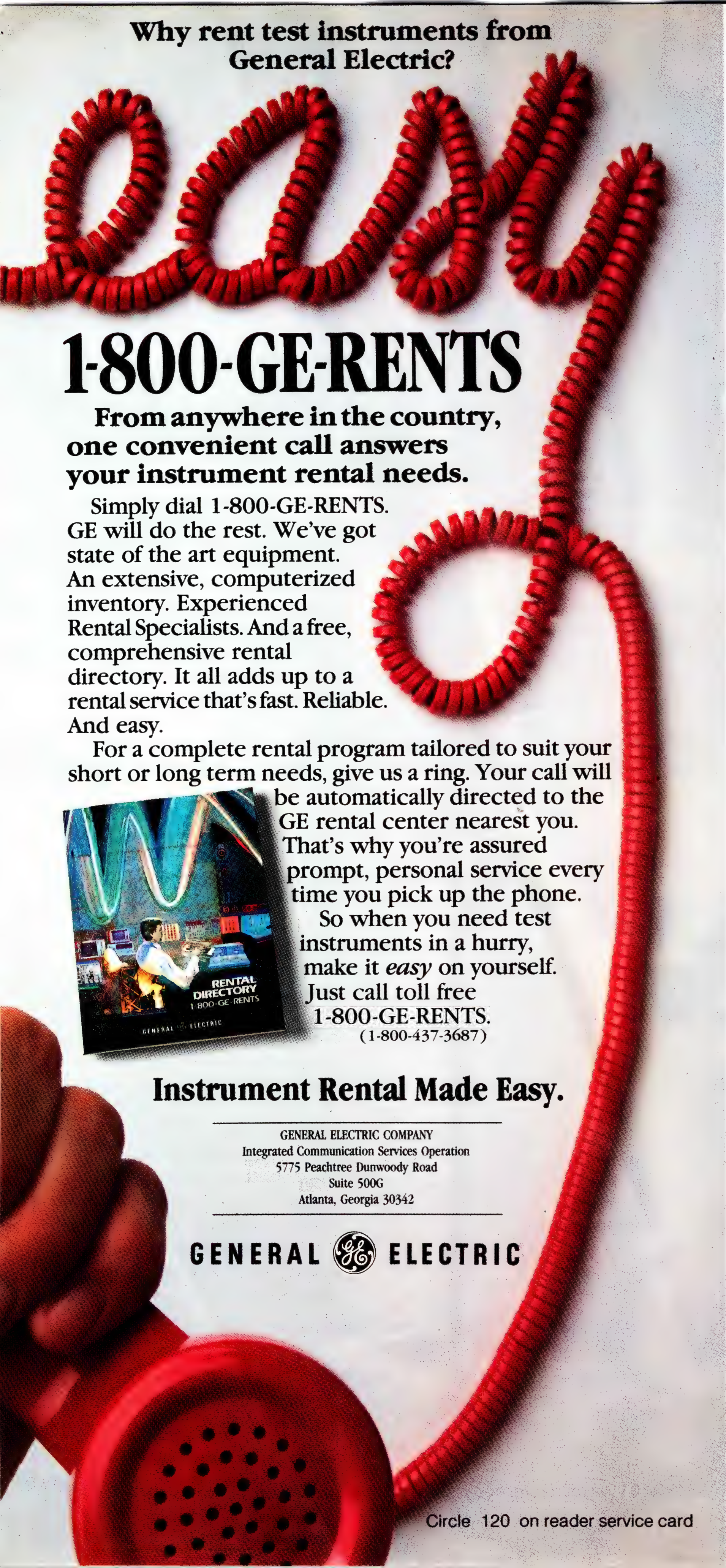

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dedicated systems, she adds. "The only impediment on an IBM PC is speed."

Most developers of publishing software have a wish list for their personal computers that includes larger screens, more disk storage, faster processing speed, and network and file systems. Brainerd of Aldus fantasizes about the ideal personal computer for desktop publishing: "A million pixels, a megabyte of memory, 1 million instructions per second, and a 20-megabyte hard disk for under $5,000." While no one is holding his breath waiting for such a machine to materialize, Brainerd does say, "In the next two years, everything you see on the dedicated systems will be done on the microcomputers."

One way the market could develop is by corporations testing the electronic-publishing waters with personal computer-based systems. "They take a nibble with a desktop system, then a bite with a couple more desktop systems, and suddenly they're forced to take a mouthful," reasons Goodstein. The need for a centralized facility and the desire to do larger projects will move companies also to purchase dedicated systems eventually, he says.

Publishing could be Apple's entry into the office market

Another school of thought believes desktop publishing or page processing will replace traditional word processing. "Word processing came from data processing, and there are a lot of things that are not in it and will never be in it," says Ken Abbott, president of Manhattan Graphics. He points out that these new packages are designed primarily as graphics products and thus incorporate many new features aimed at users who want to produce documents using sophisticated graphics processes as well as brute-force text handling.

Future Computing's Wilson believes electronic publishing will merge with word processing rather than replace it. Already, Microsoft has a word-processing program that can drive laser printers and change typefaces.

One factor preventing widespread individual use of current publishing systems is the cost of laser printers. The Apple Laserwriter retails for just under $7,000. Canon Inc., which supplies the laser for Apple, is marketing a printer under its own name for about $3,500.

But the market will explode if printer prices fall as expected. Future Computing pegs the average laser printer price at $5,500 but projects the price will fall to $2,500 by 1990, as sales jump from 83,000 this year to over 1 million. □

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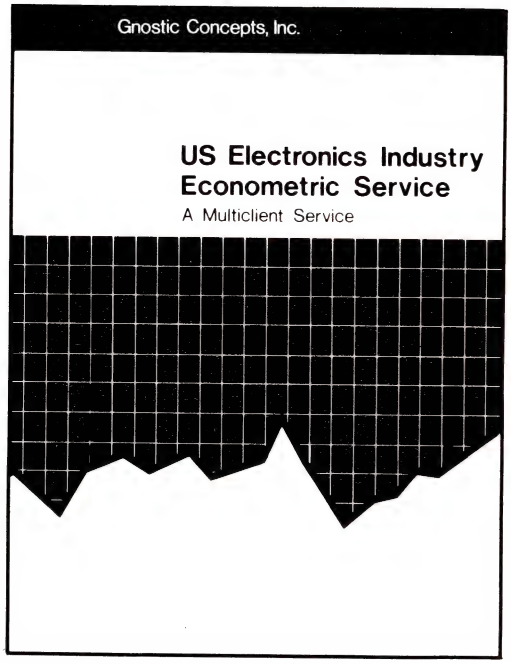
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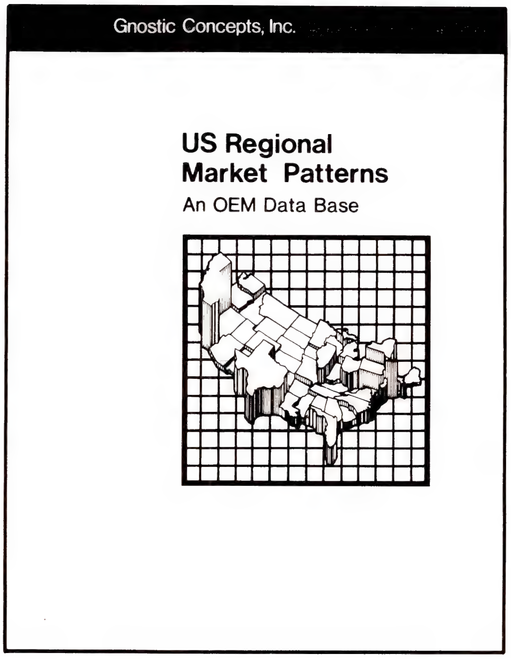
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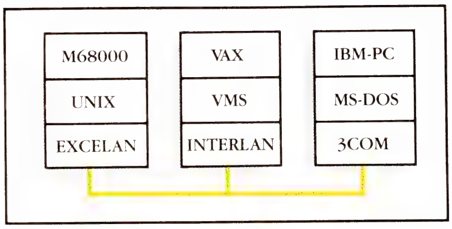

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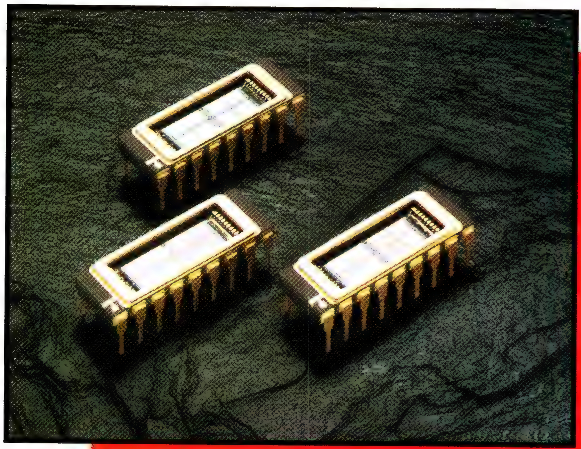

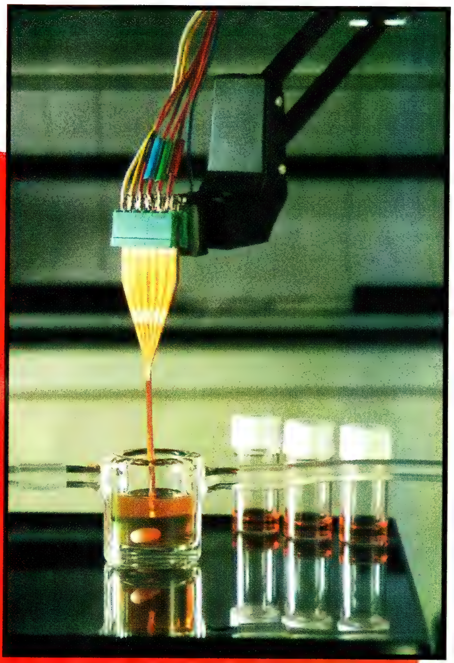

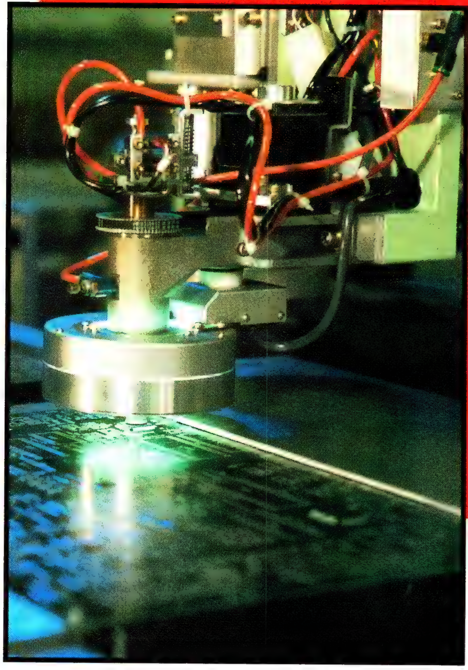

JAPANESE ELECTRONICS VENTURES IN NEW DIRECTIONS

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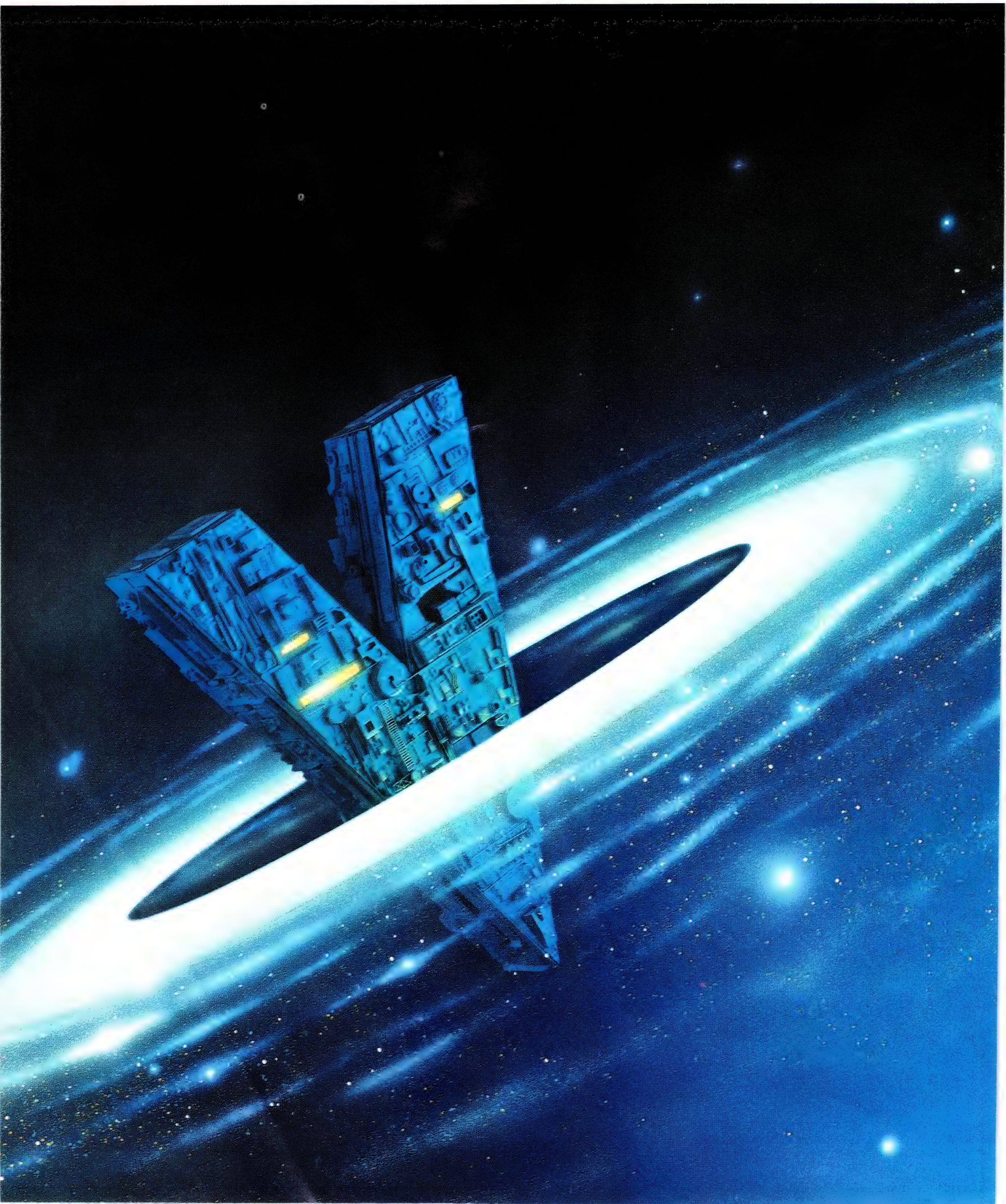
V is for V-Series, NEC's new 16/32-bit CMO



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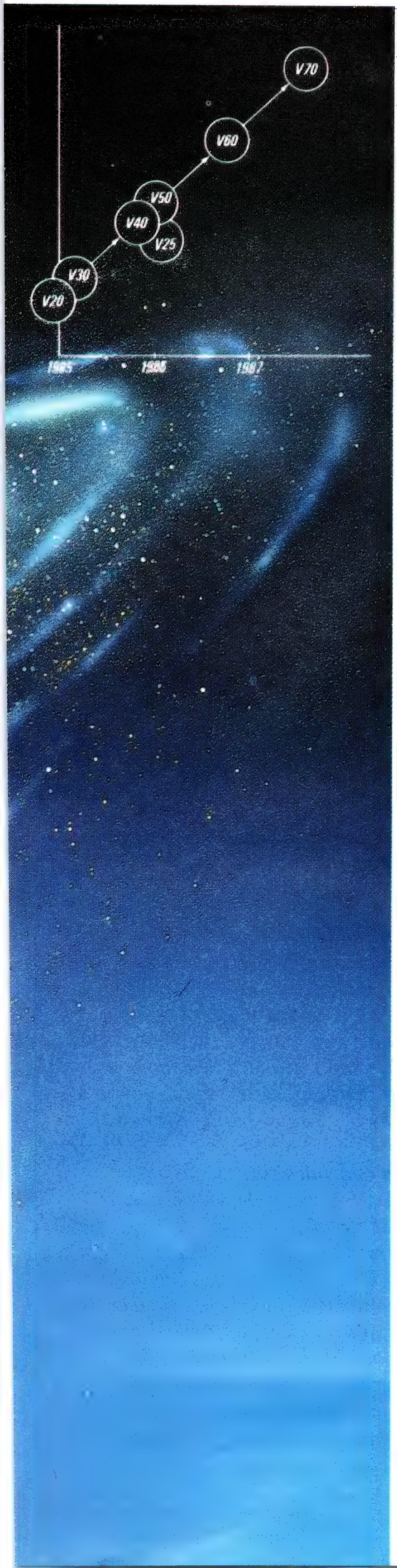

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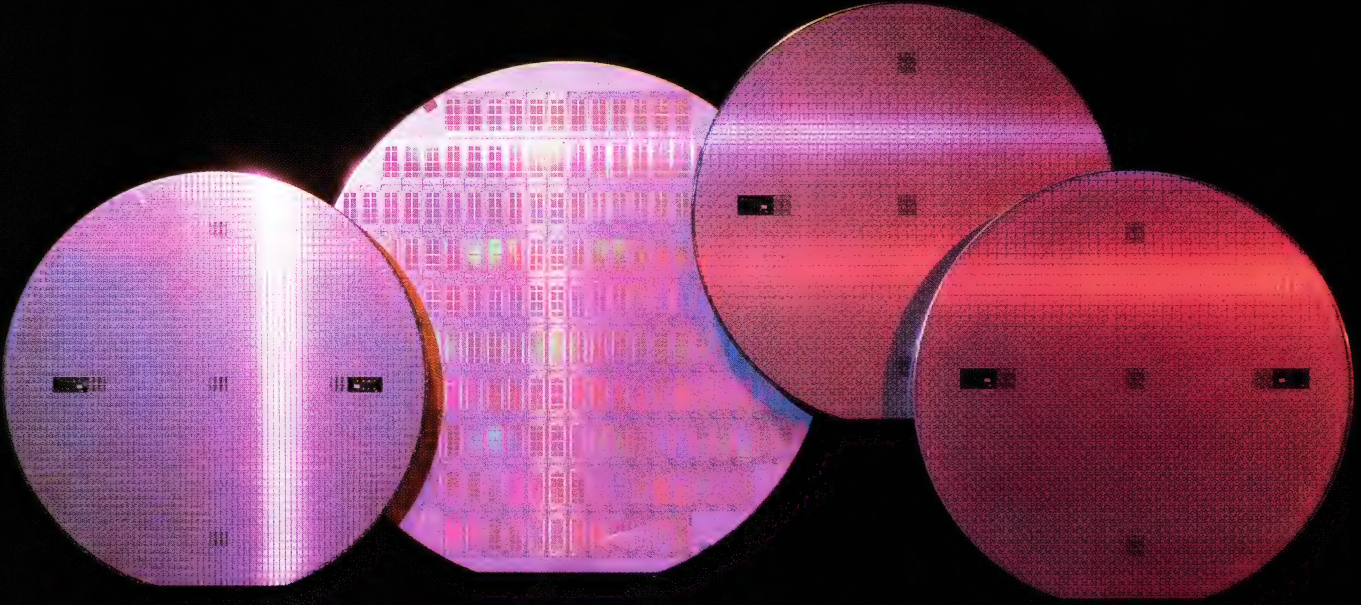

JAPAN ADVANCES TECHNOLOGY ON MANY FRONTS

There has never been a year like this past one in Japanese electronics. While the economy may have faced a chilly climate, as it did around the rest of the world, technology was basking under the sun. Japanese companies didn't huddle under a blanket; instead they braved the cold and made investments that promise to pay big dividends in the future.

This year's report covers five technology areas that either jumped into the public spotlight, as is the case with telecommunications, or have made dramatic technological gains, like robotics. Other areas covered include semiconductor production, the driving force behind the semiconductor industry; pattern recognition technology, which includes handwritten ideographic recognition as well as speech recognition and optical character recognition; and optoelectronics, a technology that is putting up more and more of a challenge to traditional electronics.

The liberalization of telecommunications laws have made this a watershed year. Most significant, without doubt, was the privatization of Nippon Telegraph and Telephone, Japan's public telephone monopoly. Much like the deregulated AT&T in the United States, the new NTT will have to compete with both domestic and foreign companies for all of the new opportunities emerging in telecommunications and value-added networks.

The following reports on these industry segments were prepared by staff writers in the Advanced Technology Industries Department of the Nomura Research Institute working under the guidance of Mamoru Kobayakawa.

Top photo: NEC's variety of semiconductor products include dual-ported RAMs for computer graphics and bipolar linear ICs for LCD color television sets.
Cover photos, clockwise from top-right: NEC's multifunction single-chip biosensor measures the urea, glucose, and potassium contents of blood simultaneously; Hitachi's mobile robots can see objects in their way, such as steps, and make decisions about what to do; NEC's robotic hand is using pattern recognition to correctly place a surface-mountable component on a printed-circuit board; Fujitsu's 1-megabit dynamic RAM features a three-dimensional stacked capacitor cell structure.

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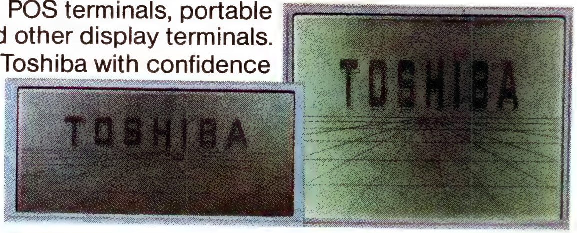
These versatile LCDs are ideally suited for applications as displays for personal computers, POS terminals, portable word processors and other display terminals. You can also look to Toshiba with confidence for a wide range of sizes and display capacity to suit your LCD requirements.



TLC-363 *TLC-402*

Specifications

		TLC-402	TLC-363B
Display			
Number of Characters		80×25 (2,000 characters)	80×25 (2,000 characters)
Dot Format		8×8, alpha-numeric	8×8, alpha-numeric
Overall Dimensions (W × H × D)		274.8×240.6×17.0 mm	275.0×126.0×15.0 mm
Maximum Ratings			
Storage Temperature		−20° – 70° C	−20° – 70° C
Operating Temperature		0° – 50° C	0° – 50° C
Supply Voltage	VDD	7 V	7 V
	VDD – VEE	20 V	20 V
Input Voltage		0≤VIN≤VDD	VSS≤VIN≤VDD
Recommended Operating Conditions			
Supply Voltage	VDD	5±0.25V	5±0.25V
	VEE	−11±3V Var.	−11±3V Var.
Input Voltage	High	VDD – 0.5V min.	VDD – 0.5V min.
	Low	0.5V max.	0.5V max.
Typical Characteristics (25°C)			
Response Time	Turn ON	300 ms	300 ms
	Turn OFF	300 ms	300 ms
Contrast Ratio		3	3
Viewing Angle		15 – 35 degrees	15 – 35 degrees

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		Low cost personal computer	Business use computer		CAD/CAM graphic terminal		
9V	Dot	—	M24JMJ00X* (0.26mm)	—	—	—	—
	Stripe	A22JCM00X (0.47mm)	—	—	—	—	—
11V	Dot	—	M29JAW00X (0.38mm)	M29JCA50X (0.31mm)	M29JCQ11X* (0.21mm)	—	—
13V	Dot	—	M34JAW03X (0.43mm)	M34JCA03X (0.31mm)	M34JKS02X (0.26mm)	M34JFM22X (0.21mm)	—
	Stripe	M34JDV13X (0.51mm)	M34JBK11X (0.41mm)	—	—	—	—
14V FS	Dot	—	—	—	M36JCA00X (0.28mm)	—	—
	Stripe	A36JFT00X (0.51mm)	M36JJQ00X (0.42mm)	—	—	—	—
19V	Dot	—	—	510ABTB22 (0.47mm)	M48JLK22X (0.31mm)	M48JKT22X* (0.26mm)	M48JMG21X* (0.21mm)

*: Under development ( ): Phosphor triplet pitch

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Telecommunications

New participants vie for position in the Japanese market as NTT goes private; revised laws give promise to overseas companies

by Hisami Mitarai

Japan's information communications industry is embarking upon a period of dramatic change, ushered in by a new legislative framework. Major new laws concerning NTT and the liberalization of the telecommunications business in general went into effect in 1985.

The opening up of the communications business, which may be regarded as a country's infrastructure, has already taken place in the United States and the United Kingdom. The legislative steps that Japan has taken make it the third country to liberalize its laws.

Although there are various restrictions on international communications imposed by worldwide organizations, the liberalization of the communications market of the U. S., U. K., and Japan, as representatives of North America, Western Europe, and Asia, will exert a great impact upon the opening up of international communications in the years ahead.

There are many factors promoting the liberalization of communications. Against a backdrop of rapid advances in telecommunications and electronics technology, the lifting of restrictions in

Focus on NEC Corp.

Tadahiro Sekimoto, president

Ever since NEC advanced the concept of C&C in 1977 by perceiving that the telecommunications industry would be developed in the form of the confluence of computers and communications, the electronics technology of the world has been progressing rapidly in the directions we predicted. C&C is now a powerful enough force to entirely transform society.

C&C comprises such basic industries as computers, communications equipment, and electronic devices. NEC is the only company to be ranked among the largest ten firms in all three basic fields. On the basis of its well-balanced, integrated technological capability, NEC is making all possible efforts to contribute to world progress through C&C.

C&C can be divided into hardware and software. The hardware is undergoing a remarkable technological development, particularly with its key components, integrated circuits, and it is vitally important to continue such development. On the other hand, software is also becoming more and more important. The software I refer to here is very broad in scope, and can be defined as the methodology for using information resources.

The importance of information for business management cannot be exaggerated. I believe that information is the fourth business management resource, following manpower, materials, and money. In other words, we are in an era where the strength of a corporation is determined by the type and kind of the information system it has.

A value-added network (VAN) is a case in point. There are two types of VANs: the horizontal and the vertical. The horizontal VAN is the system used to share information within an industry, and because of its special features, I call it the mutual, or humorously, the "strange bedfellow VAN." The vertical VAN covers a group of companies or vertically related industries, resulting in a corporate regrouping along the lines of information. I call it the affiliate VAN or fighting VAN because the reorganization of company groups may bring about new business competition.

From my definition of VAN in business context, one can easily understand the great importance of how information is used. To further enhance C&C business operations, NEC is now building a C&C VAN to offer its VAN service both at home and abroad.

It is NEC's wish to contribute to the world through C&C, while conpreserving the vitality of our organization and enhancing its technological capabilities.

the communications field (which is becoming inseparable from the unregulated business of information processing), and the ending of NTT's monopoly on the communications business have made it extremely important to introduce the so-called principle of competition. It is believed competition will reduce communication costs as well as diversify the types communication services offered.

Since NTT has built up an enormous amount of communications assets thus far, and because prior rights and interests constitute an extremely strong presence in the communications business, it may be some time before an environment of perfectly free competition materializes. Still, the legislative steps mentioned above are expected to spawn a variety of diverse communication services.

New entrants. Besides NTT, non-NTT carriers (Daini-Denden group, for example) have announced plans to enter into the field of telecommunications services. These are the Daini-Denden Project, Japan Telecom, and Teleway Japan, each of which is planning to offer services using ground communications facilities, and Japan Communication Satellite, Space Communications, and Satellite Japan, each of which will supply services through communication satellite facilities.

The plans of each of the non-NTT carriers in the ground communications group first call for the construction of communication facilities employing either microcircuits or optical fiber to link Tokyo and Osaka (and Kobe), with special line service to be inaugurated by the close of 1986. This is to be followed by the inauguration of general service (toll lines) by the close of 1987.

The members of the satellite communications group, on the other hand, intend to launch satellites in the period 1987 to 1989, begin selling and leasing transponders, and then eventually implement circuit service. The satellites are to be U. S. made,

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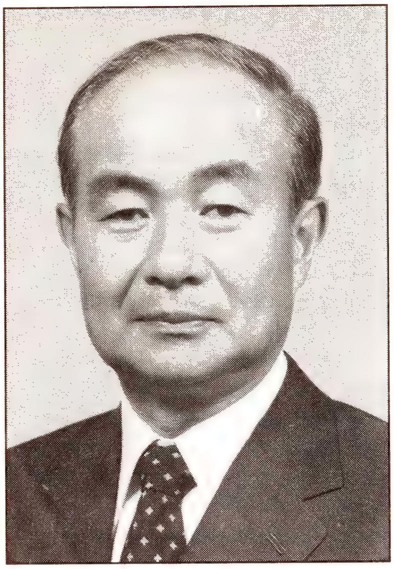

Kinichi Kadono, managing director

For this fiscal year ending in March, 1985, Toshiba Corp. had net sales of $13.3 billion, of which 31% was generated outside of Japan. A major electrical and electronics manufacturer serving markets throughout the world, Toshiba's operations comprise four segments: industrial electronics and electronic components; consumer products; heavy electrical apparatus; and materials, machinery, and other products.

In June 1985, we began delivering samples of 1-megabit dynamic RAM chips, and we will begin full-scale production in 1986. Toshiba has developed two types of 1-Mb chips—n-MOS and CMOS—in the last year; both are ideal as data storage devices. Our CMOS version has a much improved soft error rate compared with the 256-K chip, and has an access time of 60 nanoseconds and, with a static column-mode function, 25 ns.

This product is representative of the pace of development at Toshiba throughout our electronics operations. Other recent developments include a 256-K flash EEPROM.

We are a major supplier of MOS memory devices, MOS logic integrated circuits, bipolar ICs, discrete devices, and other semiconductor and related components. We also make such other electronic components as color picture tubes, circuit boards, charge-coupled devices, and semiconductor lasers.

By maintaining well balanced, timely investments in our principal semiconductor operations, we will be able to sustain a high growth rate despite occasional market downturns. Our aim is to be known as the number one maker of electronic components in the world. Achievement of that aim requires that we earn the reputation among our customers worldwide for our dependibility in supplying the full range of electronic components both in good and bad economic climates.

As an integrated electrical/electronics manufacturer, and with substantial domestic and foreign markets for our components, Toshiba is able to closely gage market conditions and deliver on commitments.

To accommodate such activities, Toshiba recently opened a new electronics engineering center, where the focus will be on the design and evaluation of new large-scale integrated devices and the development of custom products. We also operate LSI design centers in Japan and overseas. These centers, which are linked by satellites to host computers in our LSI design center near Tokyo, enable us to work closely with our worldwide customers in developing custom and semicustom products.

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procurred from such satellite heavyweights as Hughes Aircraft Co., Ford Motor Co., and RCA Corp.

Overseas activities. The market is also ripe for overseas firms. Opportunities include providing telecommunications network related services, selling advanced telecommunications equipment such as digital private branch exchanges with image, voice, and data capabilties, and establishing joint ventures with Japanese companies to take advantage of their presence in both domestic and overseas markets. Japanese corporations are particularly sensitive to criticism about their so-called closed markets and are actively pursuing joint business ventures.

The telecommunications service market itself is anticipated to grow at a sluggish rate of 8% to 9% annually in the coming years. This snail's pace growth rate, coupled with the tremendous competitiveness of NTT, which has thus far monopolized the supply of services, leads one to believe that the future of the non-NTT carriers is not likely to be rosy.

The key to business expansion rests in the capability to make full use of the latest communication and electronics technology to deliver sophisticated telecommunications services at low cost. However, the activities of all of the carriers will not stop at merely basic telecommunications service.

They are instead likely to search out new business opportunities by expanding into value-added network (VAN) services like enhanced information service or into the international communications business. In addition, the telecommunications service field will enter into a new environment of competition with the entry of these new corporations. Because of this, divisional exchange services and corporate partitioning (by business or territory) may emerge. Such a development could bring on a review of the competitive environment in various forms, and a transformation into a new structure.

Besides the field of telecommunications services, the liberalization of communications will greatly change the field of VAN information services.

VAN service in the strict sense may be interpreted as consisting of various types of communication processing services, such as protocol conversion, which enables connection between heterogeneous computers and terminals; accumulated transfer, which makes possible similar information communication; and media, code, and high-speed conversion.

Opinion conflicts as to whether this basic communication processing service could subsist as an independent business. A consensus seems to be forming around a perspective that portends the VAN supplying the above functions as a value-added network infrastructure attached to the telecommunications facilities. This view foresees the arrival of numerous business opportunities with the expansion of the various information communication services making use of this network.

Variety. Of the information communication services using VAN, the greatest hopes are pinned on on-line information processing service and on-line information delivery service. Up to now, the conventional on-line information processing service has involved mainly on-line time-shared computer services available from certain companies. However, the need for on-line information communication between heterogeneous industries and corporations is expected to grow stronger in the years ahead, and the market for remote computing service applying VAN principles is consequently anticipated to record a high growth.

A high annual growth rate, exceeding 25%, is forecasted for the market for on-line information processing service in the coming years. This rate is projected despite the substantial decline in the costs of software needed for information processing and the rise in the processing capabilities being delivered to users.

As for on-line information supply services, Japan's data base industry itself is scanty as compared to the U. S. The country lacks an indigenous, truly effective data base. But these problems are being dealt with, albeit gradually, by government-sponsored measures designed to support and foster the domestic data base industry. At the same time use is being made of the abundant overseas data bases, and static image data bases are being laid down and broadened with the penetration of videotex systems.

In consideration of this, an overall high growth (also exceeding 20% annually) is anticipated for this market. The key factor in the growth of on-line information delivery service is the degree of completeness achieved by the network services needed for use of this on-line service. This is the role that VAN is designed to play.

It should be mentioned here that NEC, Fujitsu, Hitachi, and other major computer manufacturers intend to enter the VAN service business on a full scale. Each has affiliates supplying the above on-line information processing service, and plans to extend the on-line service, also including remote-computing services, in connection with data-exchange services for the placing and receiving orders as VAN employment spreads in the years ahead.

Responsive. All of these corporations aim to develop for their users information communication systems that employ VAN, and to expand their sales of equipment and systems—specifically computers—in step with this development. It is thought that this is the primary motivation behind the plans of computer and communication manufacturers like Fujitsu, IBM Corp., and other foreign-affiliated corporations to enter the VAN business.

As they expand their VANs throughout the country, corporations will have to make an enormous effort to surpass the service capabilities of NTT in the scope, content, and reliability of the service. Still, several companies are attempting to form large-scale VANs, as exemplified by IBM's IN, AT&T's Net 1000, and those already mentioned.

Although the competition is expected to be fierce, the scale of Japan's market for on-line information service is likely to surge from its present level of 260 billion yen (1984) to 2,800 billion yen in 1995, a figure equivalent to an annual growth rate of 24%, with the emergence of VANs. □

Semiconductor Production

Aware that up-to-date fabrication equipment will keep Japan ahead in semiconductors, domestic companies begin to design sophisticated gear

by Shiro Tanigawa

Highly composite in nature, the IC industry employs the most sophisticated technology from a wide variety of fields. These include precision manufacturing technology for semiconductor substrate materials (such as various chemicals, gases, pure water, silicon, and gallium arsenide), as well as technical expertise in such fields as high-precision processing, test and measurement, computer software, high-degree vacuum, and environmental management.

Today's IC industry is supported by equipment for manufacturing and testing ICs and for growing high-purity semiconductor materials. Each of these technologies is indispensable to the subsistence of the industry. The group of corporations supplying these technologies, equipment, materials, and other related products needed by the IC industry can be collectively termed the IC peripheral industry.

IC peripheral industry sales derive primarily from capital investment and the purchase of raw materials necessary for IC production.

20% growth. Capital investment by the IC manufacturers, while fluctuating somewhat from year to year, generally amounts to 15% to 20% of the total IC production value. About 30% of this investment is for constructing new plants, renovating outdated ones, and buying environmental equipment, with the remaining 70% going for equipment like wafer processing and test systems.

The purchase of materials needed for IC production amounts to approximately another 20% of the total IC production value. The main items in this case are materials as silicon wafers, lead frames, gold lines, plastics, ceramics, and other packaging materials, as well as such materials as resist, quartz tubes, and photo masks.

Sales in this IC peripheral industry as defined above, have been expanding at a pace close to 30% annually over the last 5 years, and have currently reached the 1 trillion yen mark for the year. Increasing sales have lured a number of corporations to enter this field. The number of companies now active is estimated to exceed 600. In addition, various associations (such as the Japan Semiconductor Manufacturing Equipment Association and the Photo Fabrication Association) have been set up, providing a cohesiveness to the industry.

As for the major corporations active in the IC peripheral industry, there are few domestic corporations that are exclusively engaged in this business. In most cases, the entry into this field by

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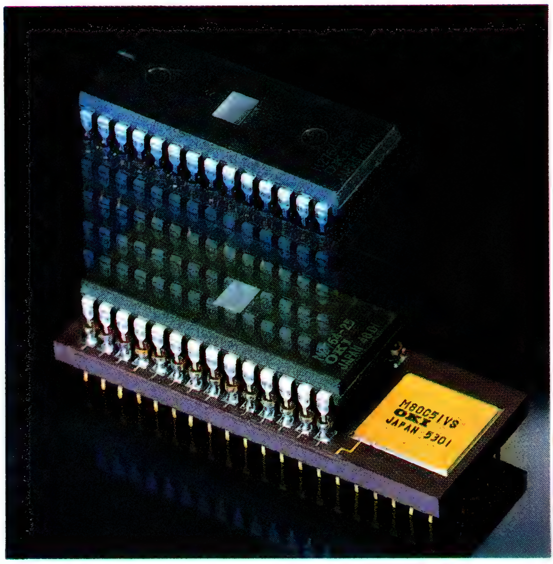
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native companies was a step toward diversification. It is also true, that there are high degrees of dependence upon foreign goods in certain specific fields, such as the most advanced products and doping gas. In such fields, overseas manufacturers and their agencies play an extremely important role. A closer look at these points in connection with the equipment and materials fields is in order.

The bulk of the corporations participating in the equipment field are on a comparatively small scale. However, there are also numerous corporations with concerns in this field that have long been affiliated with the big IC manufacturers. These include Japan Vacuum Technology, which expanded from its original business of manufacturing various types of vacuum equipment to its present activities in manufacturing sputtering and dry etching equipment, Shinkawa, the world-class wire bonder manufacturer, and Disco, the dicing saw maker.

Made at home. There are also big machinery manufacturers that have entered the business as an attempt to diversify into the bigger growth fields. These include Canon and Nippon Kogaku, which make steppers and other aligners, Nisshin Electric, which manufactures ion implanters, and Seiko Electronic, which makes molecule-beam epitaxial-growth equipment.

There have been increasing instances of big IC manufacturers making use of their stores of technology to enter this field independently or through subsidiaries. The Hitachi Ltd. Group, for example, manufactures and sells independently developed steppers, electron-beam exposure equipment, dry etching equipment, and ion implanters, as well as clean room equipment and various kinds of measurement equipment. Likewise, in the Toshiba Group, E-beam exposure equipment and epitaxial growth equipment is manufactured and sold through Toshiba Machine, and wire bonders are

Focus on Fujitsu Ltd.

Mikio Otsuki, managing director

Fujitsu was quick to recognize the possibilities of optical communications. In 1962 it began research and development aimed toward commercial use, and development continues today on a broad front from components to systems, including optical fiber, semiconductors, passive components, and repeaters.

Recently optical repeater equipment for large-capacity, long-distance carrier systems using single-mode fiber with a transmission speed of 400 megabits/s was shipped to Nippon Telegraph & Telephone Public Corp. (NTT) and common carriers in the United States. An even more recent product of R&D is the optoelectronic integrated circuit (OEIC), in which optical elements are integrated with electronic circuits on a single semiconductor chip.

An OEIC is far more compact than the conventional combination of electronics with discrete optical elements. For example, a laser and its driving circuit, or a p-i-n photodiode along with its preamplifier circuit can be built on a single OEIC. These OEICs have been coupled to optical fibers to form modules, and good transmission characteristics have been obtained at 400 Mb/s. The future will see the commercialization of this technology, together with the development of devices in the gigabits/s range.

In the field of business communication networks, last November NTT began offering a high-speed digital service (64 kilobits/s to 6.3 Mb/s) in Japan. Many corporations are taking this opportunity to review their networks in search of lower communications costs, creating a spate of openings in the business-communication network market. Fujitsu is taking advantage of the opportunity with its Corporate Information Network Systems concept, which includes a line of products like multimedia multiplexers and private branch exchanges.

The trend toward digital networks also affects the field of radio. Quadrature amplitude modulation (QAM) is used in many areas to enable large amounts of information to be transmitted in restricted frequency bands. Using its capabilities in microwave ICs and gallium arsenide power amplifiers, Fujitsu has developed 16-level QAM systems and 64-level QAM systems for NTT and common carriers in the U. S., and has began work on a more efficient 256-level model.

Fujitsu continues to emphasize R&D in optical communication, business communication networks, and digital microwave communication, with the goal of helping build an integrated services digital network.

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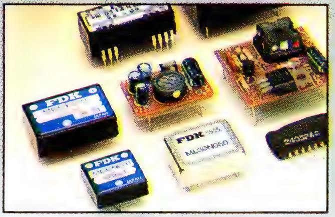
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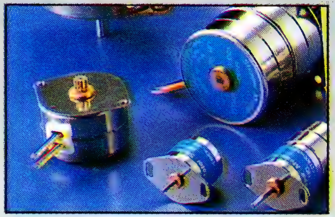
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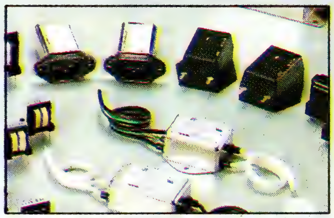
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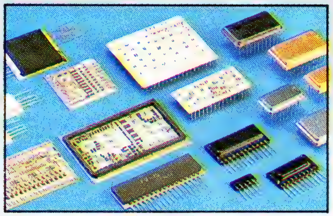
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made and sold by Toshiba Precison. In the same vein, NEC has turned its hand to mask repair equipment that employs laser technology.

As this suggests, Japanese companies are making a vigorous effort in the equipment field in recent years, but the fact is that the role of overseas manufacturers in this field is still a substantial one. Even at the present time, roughly 30% of Japan's IC manufacturing equipment is imported from overseas manufacturers. In each of these cases, the equipment applies the most advanced technology; prime examples include molecule-beam epitaxial-growth equipment, high-current ion implanters, X-ray exposure equipment, and various types of test and measuring equipment.

The expansion of Japan's IC industry has obviously made the country's equipment market more and more attractive to overseas manufacturers.

Focus on Oki Electric Industry Co., Ltd.

Oki Electric's mastery of very large-scale integrated-circuit technology and our company-wide commitment to quality-assurance and reliability has propelled the Electronic Devices Group to the forefront of the world semiconductor industry. As a result, Oki is now a major force in the electronics revolution that is reshaping business and society.

Oki is firmly on track toward our overall annual sales target of $5 billion by 1990, and the foundation has been laid for quantum technological leaps in the next few years. Sales in fiscal 1984 climbed above $1.67 billion, an increase of 14% over the previous year. The Electronics Devices Group accounted for 22% of revenues.

With broadbased experience and comprehensive product offerings in office-automation, telecommunications, electronics, and information processing, Oki is determined to press its advantages as an integrated electronics manufacturer.

Oki's reputation as a world leader in mass-producible CMOS technology dates to the late 1970's when Oki captured more than 30% of the world digital-watch market. History has vindicated Oki's farseeing estimates of the rapid growth in demand for VLSI memories and CMOS microprocessors throughout the 1980s. Oki has developed a VLSI technology with 1.2-micron geometries that will be used for 1-megabit dynamic RAMs; these are due for mass production next year.

As our technological and production capabilities have reached new heights, Oki's Electronic Devices Group has also moved forward with international joint production arrangements in line with the emerging worldwide industrial trends. Licensing agreements exist with Intel Corp., Santa Clara, Calif., for second source production of Intel's microprocessors; National Semiconductor Inc., Santa Clara, Calif., for codevelopment of MOS products; and with Thomson Group of France for second sourcing Oki-designed application-specific products.

Oki understands that no area is more critical to success than service. Therefore we have tailored our multinational strategy to optimize every phase of service, from computer-aided design tools that can be accessed at any stage in the development cycle in our Design Centers to a range of packaging options unmatched in the industry.

Responsiveness is the keystone of Oki's approach—from initial definition of user needs to gathering feedback on products that are already in use. Inspired research and development programs have also been crucial to Oki's progress and our efforts are now more relentless and forward-looking than ever.

Teams of engineers are attacking a spectrum of technologies covering materials, design strategies, production processes, and CAD and computer-aided manufacturing systems. Oki Electric's R&D vision spans several generations into the future, ensuring that the company stays in the vanguard of progress.

Yoshio Masuda, senior managing director of Oki; president of Electron Devices Group

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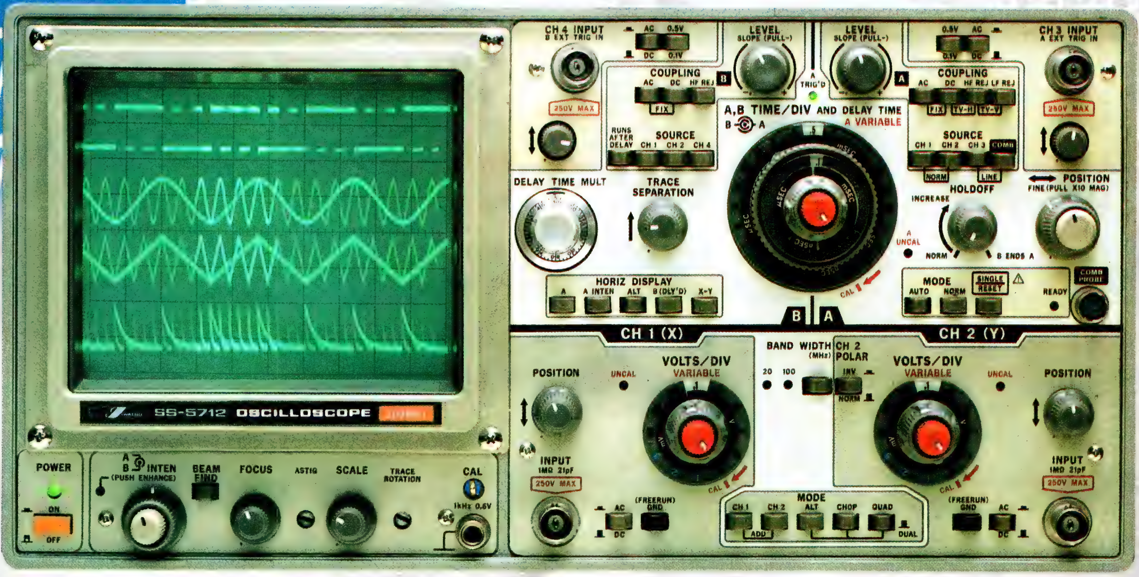

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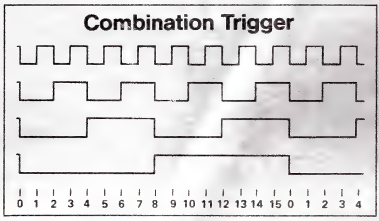

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Circle 55 on reader service card

These foreign firms show signs moving away from sales conducted through import agencies, as has been the case thus far, to full-scale business expansion in Japan, including constructing plants.

Raw materials. In the area of materials, with certain exceptions (doping sources and resist, for example), the bulk of the materials are supplied by domestic corporations. Most of the domestic corporations in this field are of a medium standing. In recent years, however, some big raw materials manufacturers (such as steelmakers) have moved into this field as part of a program to diversify into higher growth fields. As in the case of the equipment field, overseas manufacturers have embarked upon plans for the construction of plants within Japan.

Aside from the above fields, the large-scale integrated-circuit-design design business can be cited as a field which has been garnering an increasing amount of attention the past few years. The spreading use of ICs and the greater diversity of user needs accompanying it have made it impossible for the IC manufacturers to keep pace with design purely on the strength of their own internal capabilities. This situation has spawned this new field of business. This development resembles the way software houses have sprung up along with the growth of the computer industry. This year is expected to see a rise in the use of such semicustom devices as gate arrays and standard cells, and it appears that this field will experience a rapid growth as a result.

Growing list. At the present time, the list of corporations active in this field contains the names of the subsidiaries of the big IC manufacturers (for example, NEC IC Microcomputer Systems, Hitachi Microcomputer Engineering, Toshiba Microcomputer Engineering), photo mask makers, and commercial firms handling semiconductor devices.

The outlook is for a further increase in the number of corporations participating in this field in the coming years, and a diversification of the substance of this business. □

Pattern Recognition Technology

Continuing advancements are pushing pattern recognition technology toward ultimate goals like deciphering human handwriting

by Masakazu Kimura

Pattern recognition technology (PRT) may well become the driving force for new computer terminals and test and measurement equipment. A multifaceted discipline, PRT embraces the identification of such patterns of data as voice, letters, objects and such senses as touch, smell, and taste.

At the present, three specific applications are contributing to make a market of respectable proportions in PRT. These include optical character recognition (OCR) as used in facsimile machines, voice recognition as employed in voice sorting equipment on assembly lines, and object recognition as used in vision systems for factory automation equipment.

Future challenges. In the future, however, PRT will invade a whole new spectrum of fields in office-, factory-, and home-automation. And then its huge, but latent market will be unleashed. For example PRT is an ideal method of automating data input. In recent years, the input bottleneck has become a problem of growing proportions. PRT would solve this a single stroke. This in turn would allow office-, factory-, and home- automation to acquire greater market penetration.

The truth is that PRT consists of a system of technologies that are both broad in scope and of considerable depth, and therefore is not of the sort to make great strides overnight.

Quantifying market needs is also difficult in the case of PRT. Furthermore, since this type of equipment is highly custom in nature and not easily suited to mass production, in most cases the development of products of an international flavor would be difficult. In these and other ways, it is quite a different beast from general electronic technology.

For these reasons, industry has taken a wait-and-see attitude toward PRT; to wit, PRT is a technology that must be promoted with a long term view in mind, and one that it is important to promote, but not one to be hastily approached in the short term.

Recently, however, certain industrial circles have begun to believe that this attitude must be substantially modified. This is partially due to a number of changes in the both the level of technology and the market conditions.

Handy. In the field of character recognition, handwritten ideographic OCR is the final target. While still at a low degree of technical perfection, it has nevertheless entered the stage of limited but practical use. There is an increasing possibility that the OCR market will expand dramatically. In addition, on-line character recognition has begun to see practical use, and the high-priced image that character recognition technology has earned is in the process of being erased.

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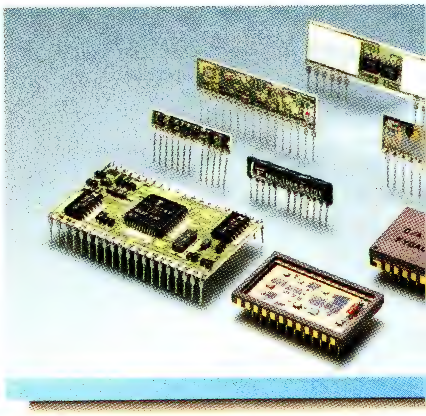

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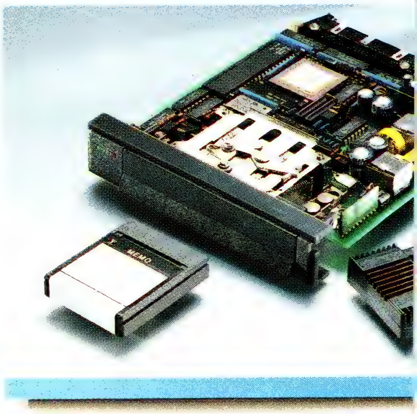

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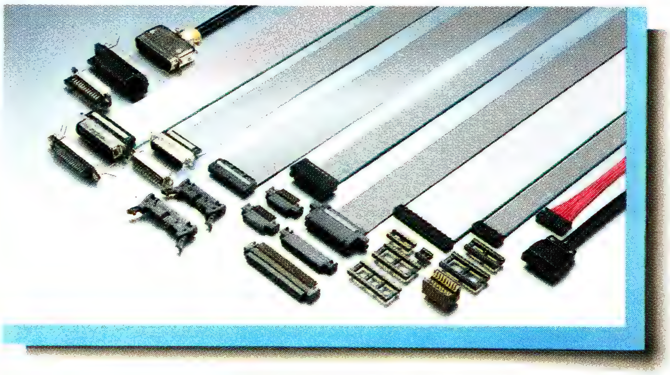
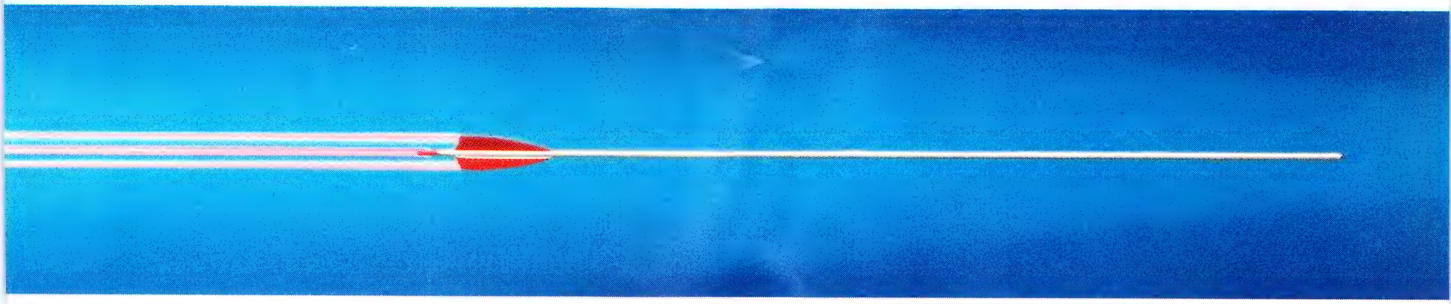
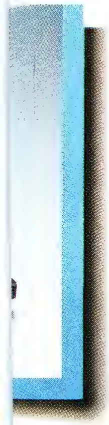
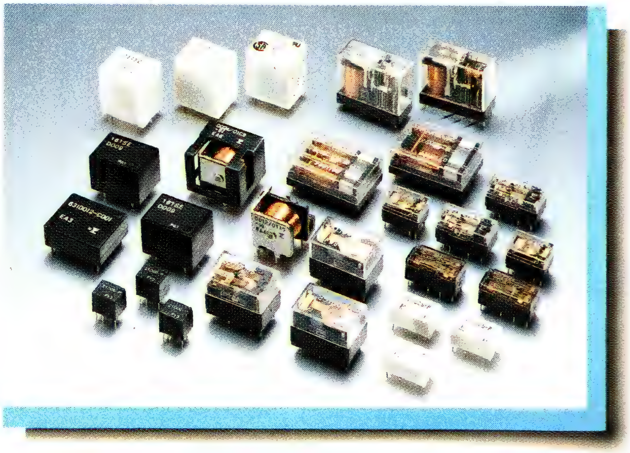


electronic components.







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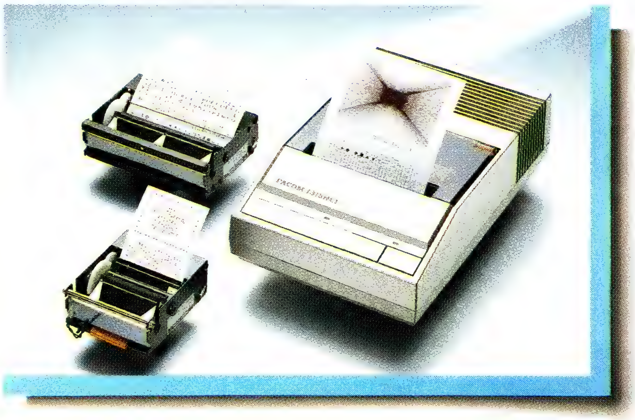

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Circle 60 on reader service card

In the field of voice recognition technology, regarded as the ultimate man-machine interface, the speaker-dependent, limited-vocabulary type of system has substantially come down in price, and its full-scale introduction has come under consideration not only in the office- and factory-automation fields, but in the home-automation field as well. In the wake of this development, the speaker-independent, limited-vocabulary type and the speaker-dependent, unlimited-vocabulary systems have entered the stage of practical use. Likewise, the final target of voice recognition, namely, speaker-independent systems that can recognize continuous unlimited vocabulary are gradually acquiring an air of reality as a topic of technology development for the 1990s.

In factory automation, where the goal is enhancing assembly and testing processes, a primitive PRT is gradually securing a foothold in the form of machine-vision technology. The intensification of visual technology for the recognition of stacked objects, coloration, and the detection of minute defects has come into the limelight as an factory automation theme of the highest priority.

Strong basics. Advancements in the basic technologies that support PRT also afford reason for optimism. These developments include the increasing capacities of memories; the practical use of high-speed devices, most importantly those constructed in gallium arsenide; the advance of picture processing technology revolving around parallel processing; the progress of post binary logic circuit technology (most importantly fuzzy logic); the emergence of optical technology employed within equipment; the heightened activity in the development of such next-generation computers as parallel processing systems and data flow machines; the increasingly vigorous efforts of industry, universities, and the government in connection with artificial intelligence; and the advance of communications network technology. All of these exert a great impact upon the expansion of PRT into systems.

In a word, the changes described above signify that PRT, previously regarded as some kind of dream technology, has finally reached a point allowing it to be recognized as a working technology. It goes without saying that attaining the final, high-level PRT application goals is still a long way off. Nevertheless, the amount of recognition equipment that can be produced from the current of the technology is great.

Furthermore, it is now fully possible that PRT will achieve a breakthrough to a higher level. The present situation calls for industry to come to resolute grips with their work in this field. □

Focus on Graphtec Corp.

Mitsuo Yamaguchi, president

Graphtec Corp. has specialized in producing recorders and pen plotters since the company was established in 1949, and we have always placed great emphasis on reliability and quality. Accordingly, Graphtec products are now highly regarded by end users throughout the world, and I believe that we have established a firm foothold in these market segments.

There have been tremendous advances in computer and digital technologies, and although digital products are vying with analog products for a share of the market, the demand for analog recorders has increased. I believe that this is because analog products appeal directly to the human senses.

Our line of recorders has been designed to meet varying user needs and budgets, and we can offer over 100 different models. Our lineup comprises pen oscillographs (linearcorders and miniwriters), X-Y recorders, and strip-chart recorders (mutlicordres, servocorders, and hybrid recorders).

The earliest plotters were devices that simply reproduced in graphic form the information received from a computer. Today's plotters are multi-pen, intelligent, and highly accurate; users can choose from flatbed, drum, and hybrid pinch-roller types. Plotters are widely used in industry, research, business, and education, and they are by far the most popular output device for computer-aided design systems.

Also an essential part of a CAD system, a digitizer is an input device that employs innovative technology to read and transmit data to a computer. Our digitizer lineup ranges from compact models to large-format versions. They are used for such various applications as business graphics, inventory control, architectural design, cartography, and laboratory analysis.

Graphtec Corp.'s goal is to continue its efforts to develop attractive products that meet user needs.

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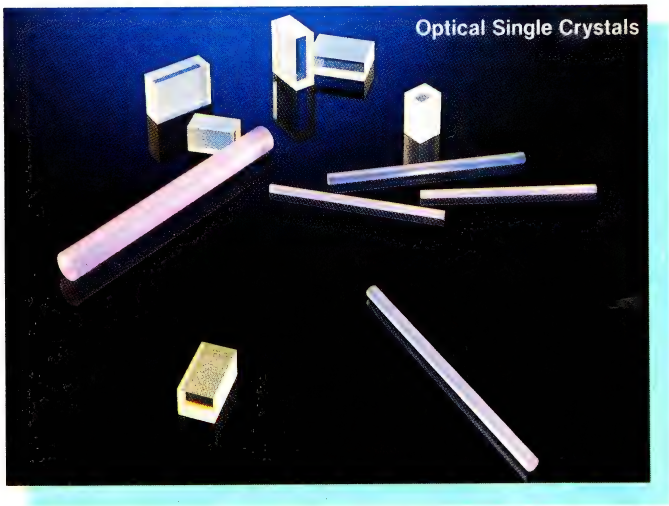

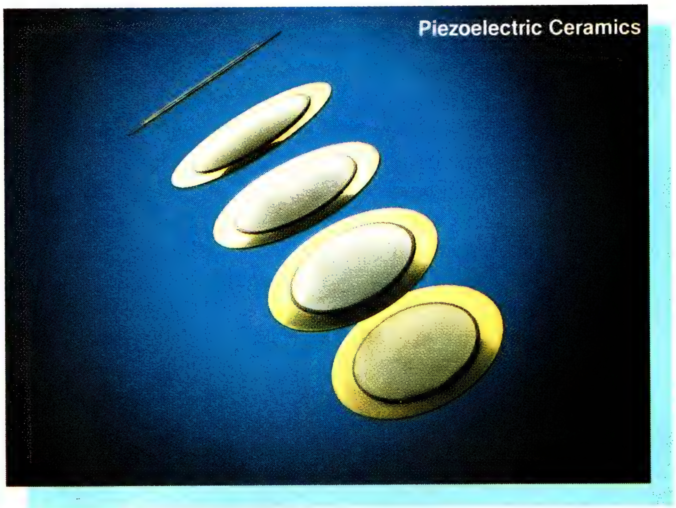

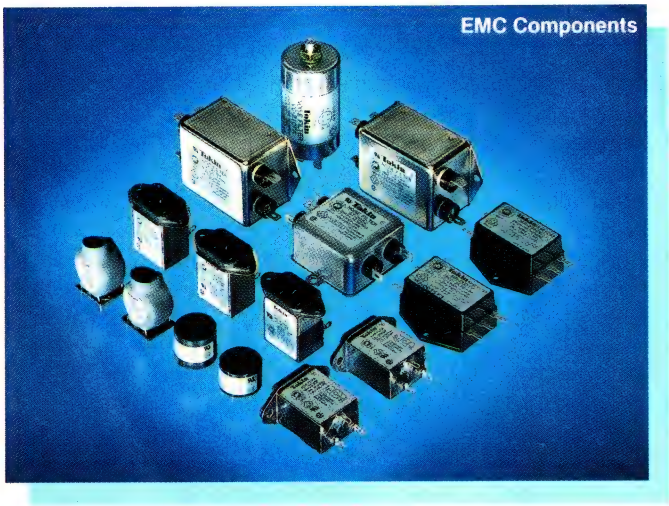

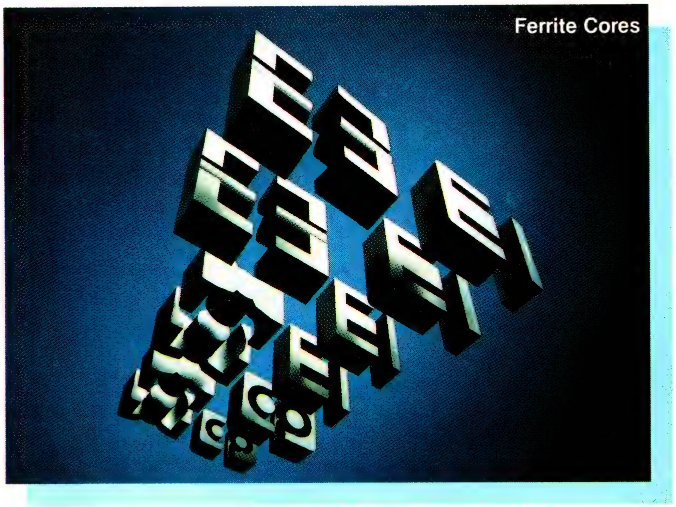

《 *Please note our new name,* **Tokin Corporation**, *starting June 27, 1985.* 》

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Circle 62 on reader service card

Optoelectronics

Wide-ranging developments open new markets for optical technology

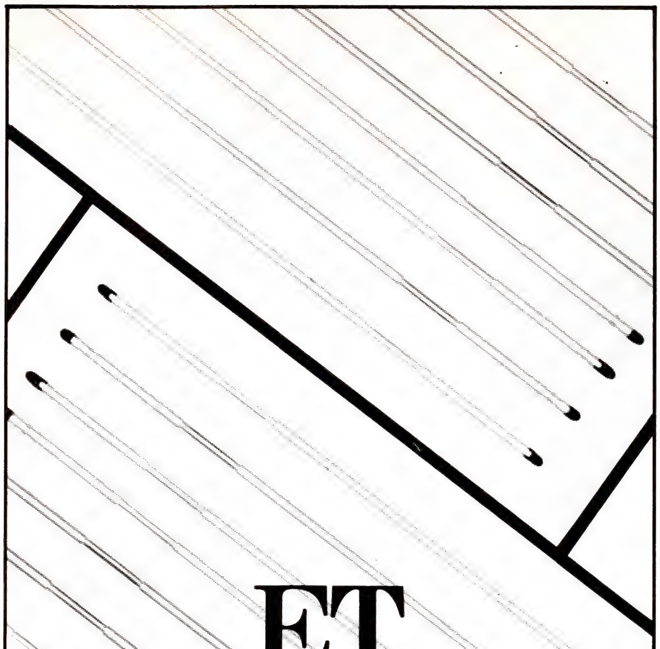
by Naoki Ikezawa

Last year was brimming with news concerning optical technology and the fiber optics industry. In the area of optical elements, distributed-feedback (DFB), and multiquantum well (MQW) lasers were developed, as well as super high-speed (over 1 gibabits/s) optoelectronic integrated circuits (OEIC) and light-emitting diodes (LED).

In the area of optical fiber, the vapor-phase axial deposition (VAD) method patents were opened up in January to three telephone line companies in addition to Sumitomo Electric Industries, Furukawa Electric Co., and Fujikura Cable Works. In the field of materials, several organizations announced untransposed gallium arsenide single crystals and gallium arsenide ICs.

The single crystals are indispensable to the successful fabrication of high quality OEICs. Fuji Electrochemical Co.

Hitachi has developed a new CAD that analyzes the electrical properties of three-dimensional semiconductors using the S-80 computer. CAD is expected to play a major role in developing the next generation of ultra large scale integrated circuits.



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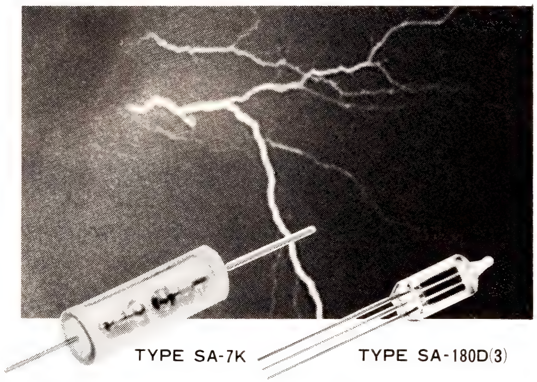

● *TYPE*

Type	Breakdown Voltage (V) DC	Insulation Resistance (Ω)	Maximum Surge Current (8×20us) KA	Life Times at 500A
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SA-200SS	200±10%	10^{10} min	1.0	1000
SA-80	80±10%	10^{10} min	1.5	1000
SA-140	140±10%	10^{10} min	1.5	1000
SA-200	200±10%	10^{10} min	1.5	1000
SA-250	250±10%	10^{10} min	1.5	1000
SA-300	300±10%	10^{10} min	1.5	1000
SA-7K	7000±1000V	10^{10} min	—	5000
SA-10K	10000±1000V	10^{10} min	—	5000
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● *POINT*

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● *APPLICATION*

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claims the credit for first developing the world's largest spinel type of ferrite single crystal. Following this, Fuji successfully fabricated a yttrium iron garnet ferrite single crystal. Fuji's commercialization of this propelled the firm, which originally was founded as a battery maker, into the forefront of the optoelectronics business. There was also a lot of news in such other fields as optical disks and sensors, solar cells, and power lasers.

But as might be expected, the most important story concerned optical communication systems. In short, there was a stream of developments, such as Nippon Telegraph & Telephone Public Corp.'s construction of a trunk network that transverses the length of the country, the unveiling of the concept of a group of several non-NTT carriers, the inauguration of information network system (INS) testing, and the privatization of NTT itself.

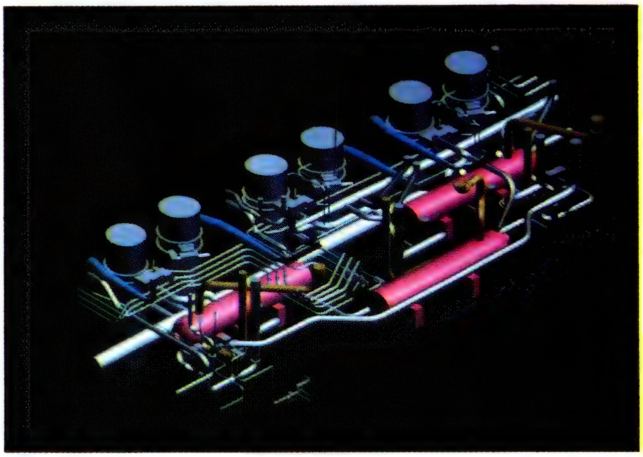
These will no doubt exert an enormous impact upon Japan's society and industry. Another notable point concerning optical communications is that simplex digital links (links used in optical communication systems of a lower speed and shorter distance than in the case of mass communications) have become widespread.

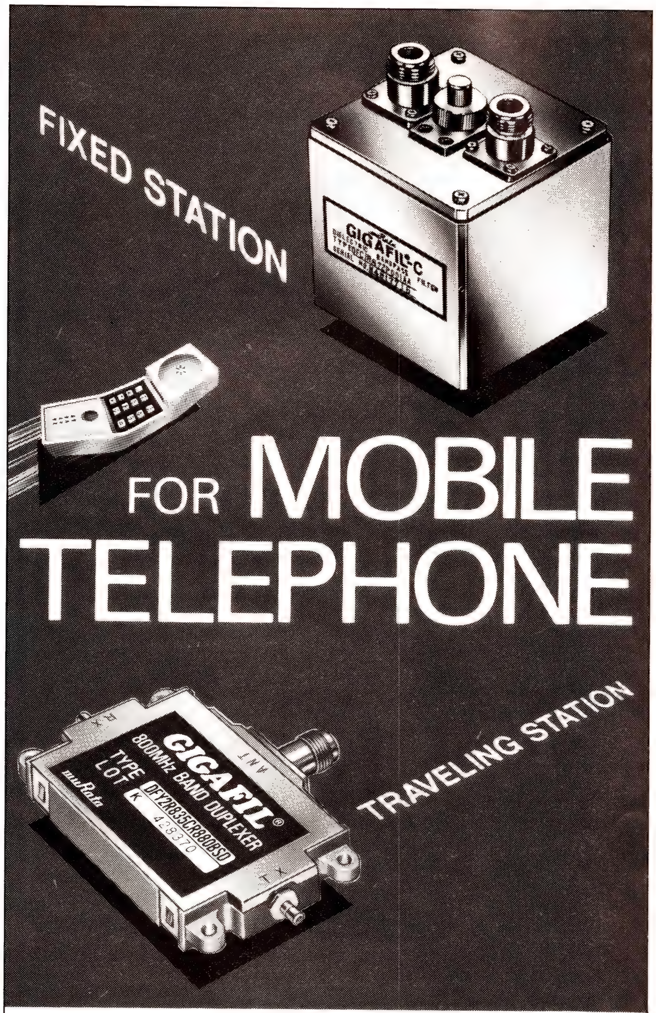
Multipurpose. Optical communication technology first materialized in long-distance, high-capacity communications. Recently, however, it has been incorporated into short-distance communications, resulting in the spread of simplex digital links noted above. This trend is occurring primarily because of the advance in optical technology; basic optical products and equipment are being improved and their cost is coming down.

Steady advances will no doubt continue to be made in optical technology in the years ahead, and thus the use of optical communication systems for shorter distances will also presumably continue to make progress.

The use of optical communication systems for short

This CAD system from Hitachi incorporates a three-dimensional surface display processor and voice recognition capability. The system's display has a resolution of 2,448 by 2,048 pixels.





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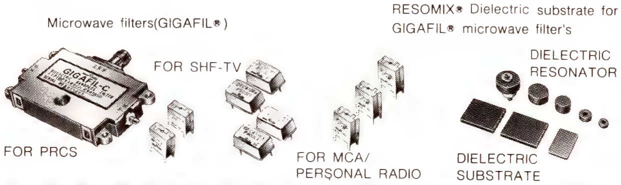
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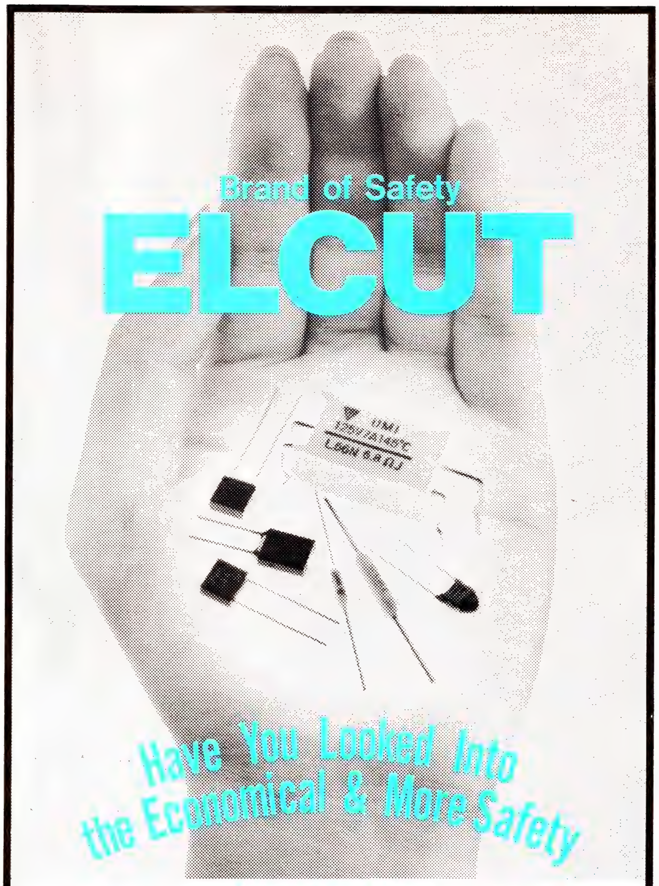

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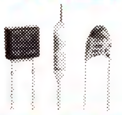

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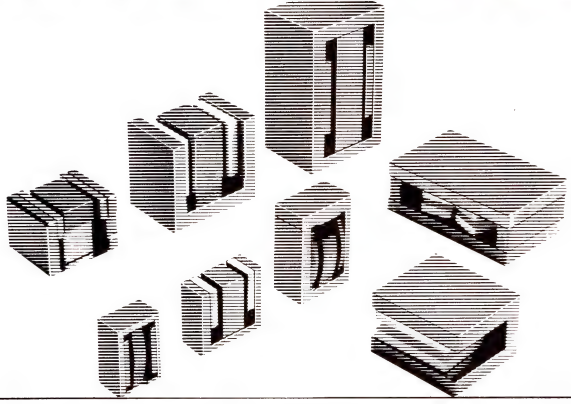

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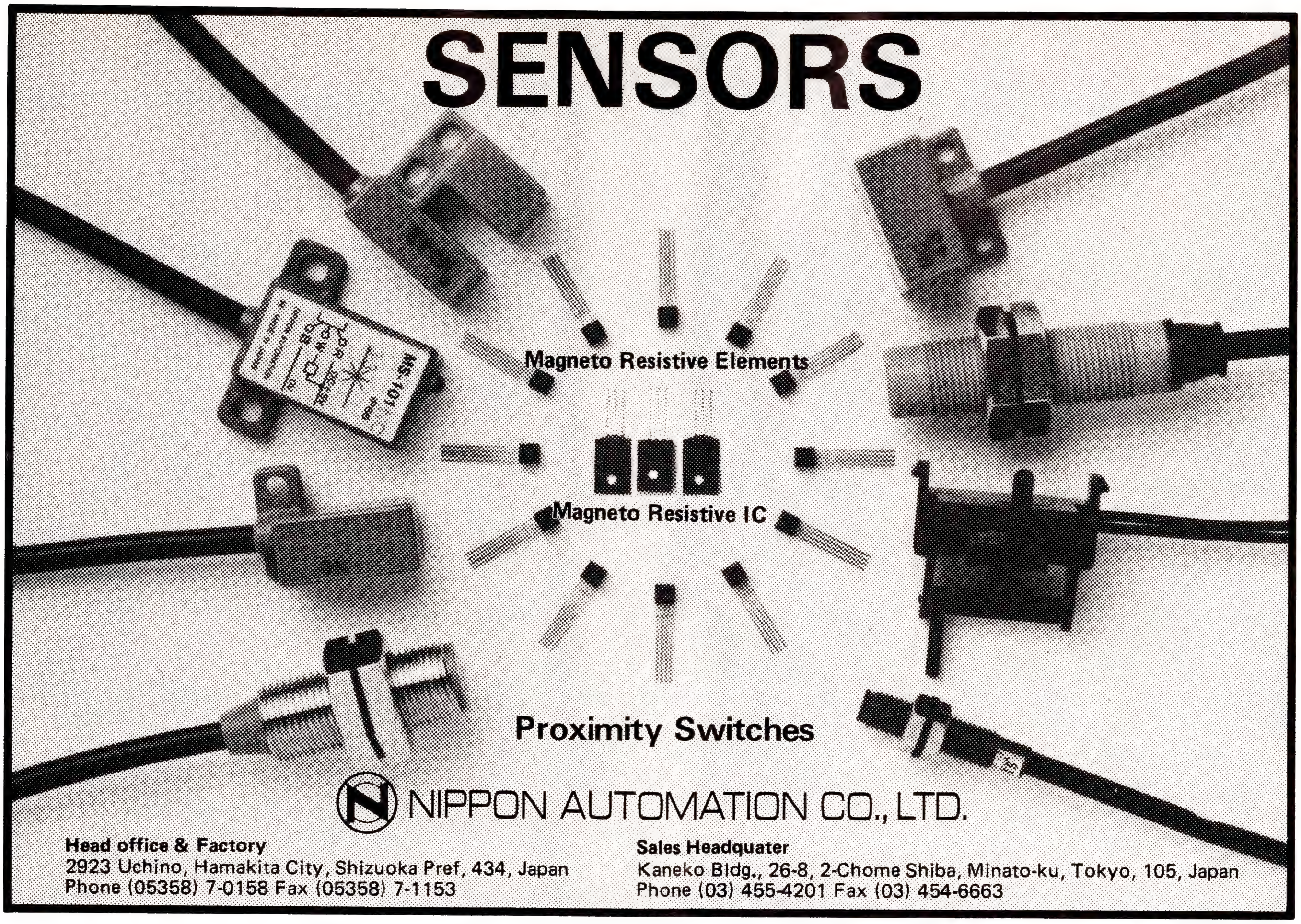

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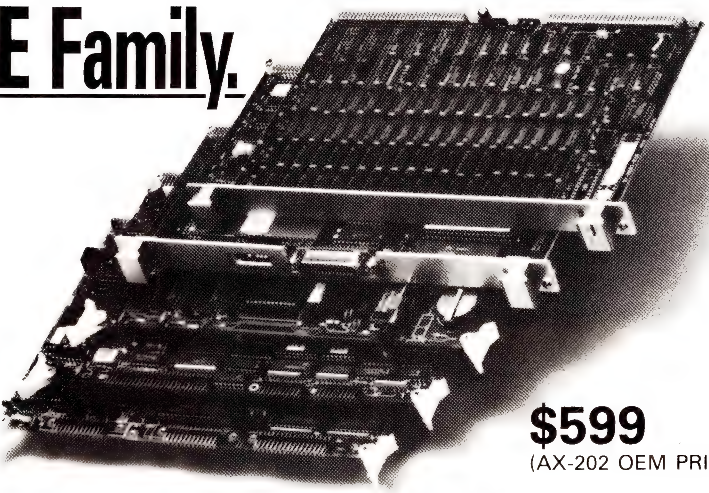

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distances will result in the emergence of optical interconnections within machinery and equipment. The gradations of optical interconnection will occur on three levels, the first two parallelling that of long- and short-distance communications.

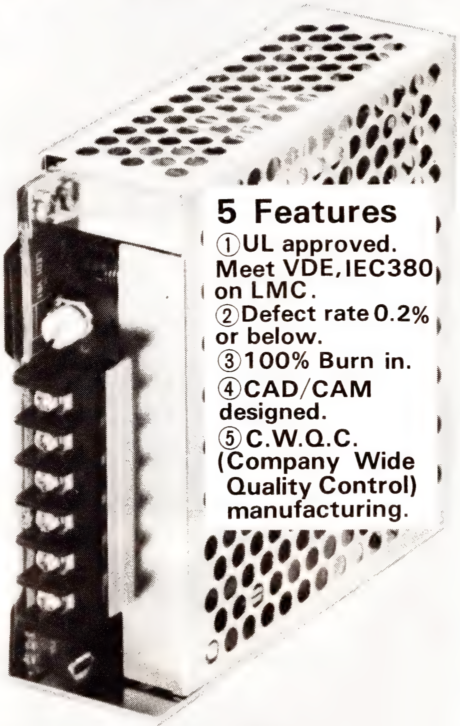
Optical interconnection between machinery and equipment involving long distances represents the conventional optical communications. When used to link the machine itself and its peripherals or to connect printed-circuit boards and their backplanes, optical interconnection is akin to shorter distance communications. The ultimate goal, however, is the optical interconnection between elements. This will come about with large-scale OEICs, the processing elements of the future.

The field of optical interconnection, which occupies an intermediate position between the field of optical communications currently in practical use and the future large-scale OEICs, can be dubbed the Optical Circuit and Component (OCC) field. It will take concrete form on the heels of short-distance optical communications using simplex digital links.

Processing too. More specifically, the most basic of the OCC functions is transmitting signals by applying light. Such processing-type functions as signal switching, digital-to-analog conversions, and parallel-to-serial conversion are examples of more sophisticated functions that can eventually be achieved with OCC. In order for OCC to emerge as an actual interconnection component, it must conform with the existing electronics technology.

In other words, since OCC is a technology to be used within equipment, it must be capable of connecting with the surrounding electronic technology (specifically electronic components). In this sense, OCC input-output basically takes an all-electric form or that of an electric-optic hybrid, that is, electronics-in—electronics-out, optical-in—electronics-out, or electronics-in—optical-out. Unless the microprocessor, which forms the nucleus of the current electronic technology, is converted to OEICs, optical components in the true sense, that is an all-optic format (optical-signal-in—optical-signal-out) will not become a reality.

The emergence of such OCCs would in turn spawn optical PCBs and hybrid ICs corresponding to their electronic counterparts. This would also make it possible for optical technology to move beyond its conventional usage in mere point-to-point signal transmission to a circuit technology that exhibits a more network-like nature. □



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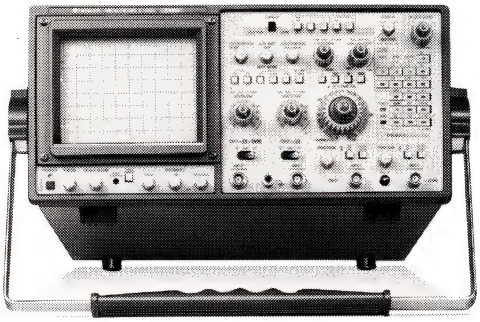

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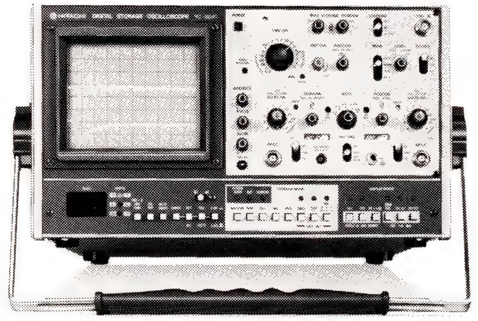

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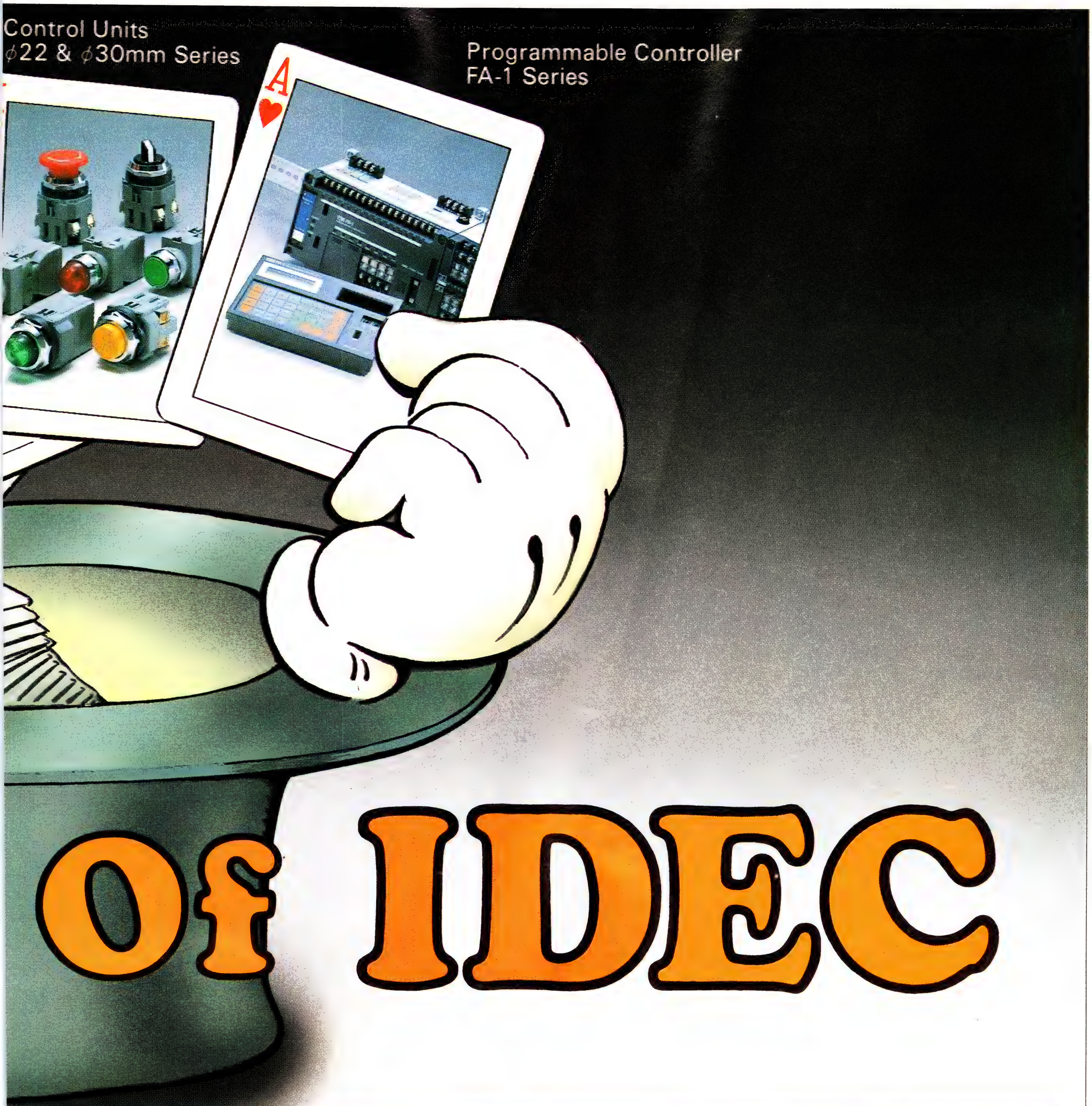
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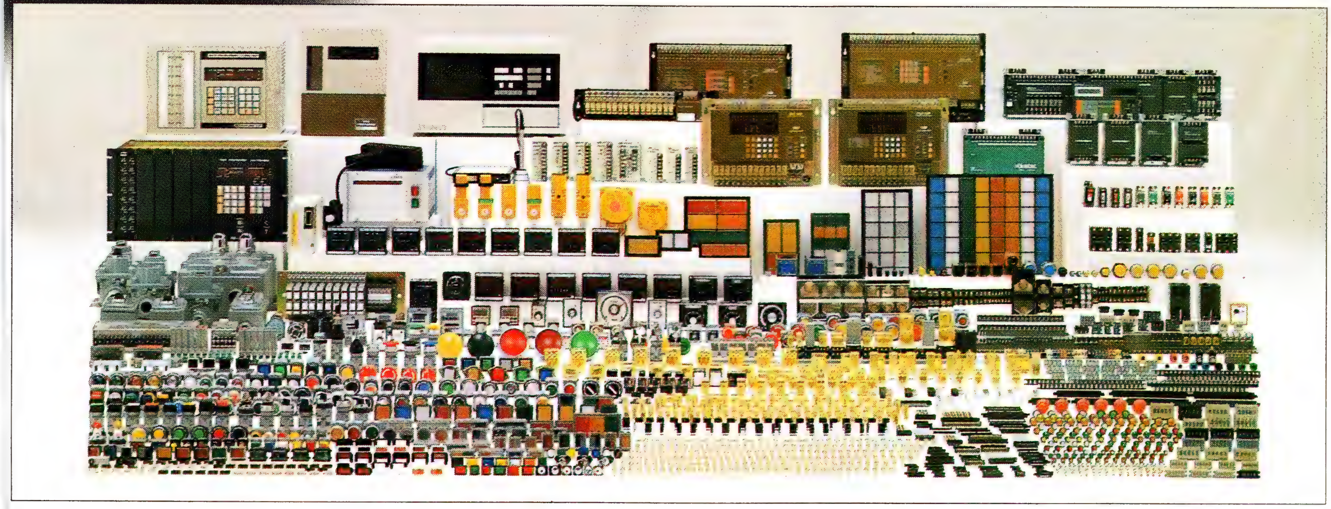

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Robotics

Already a leader in robots for manufacuturing applications, Japan finds new uses for robots in agriculture, mining, and construction

by Kensuke Shima

In many high-technology disciplines, Japan, the United States, and western Europe are battling head to head. But in the field of industrial robotics, Japan clearly has the upper hand.

Ironically however, the industrial robot was first put to work in Japan through the pioneering efforts and technology of the US. What triggered the global diffusion it is enjoying today was Japanese efforts to boost the reliability of the robot.

In recent years, the country has developed lateral, multi-jointed types for use in assemblying lightweight components, and these are being shipped to countries around the world as indigenous Japanese products.

By now it is well known that the robot was the focal point of the automation of in-plant production processes in the early 1980s, and it would be no exaggeration to say that it is central to the promotion of factory automation in the coming years. Robot introductions began with the automobile makers and other big manufacturers, but from a comparatively early date, the robot also began to penetrate small and medium-sized corporations troubled by chronic shortages of youthful, skilled labor. The robot is currently finding a wider and wider range of applications.

More research. Recently, there has been an increasing amount of fresh development aimed at using robots outside of production processes. One of the major manifestations of this trend is the large-scale national project inaugurated by the Ministry of International Trade and Industry, called Advanced Robot Technology Ultimate Work Robot R&D. The goal is to develop robots that can take over for humans who work in dangerous conditions, such as periodic inspection in nuclear power plants or at the scene of fires. The development was launched in fiscal year 1984 with a total budget of 20 billion yen for an eight-year period.

Another illustration is the increasing interest in amusement robots exhibited in the last couple of years. Amusement robots are used to lure customers into stores, promote sales, and entertain people. Unlike the purely mechanical models of the past, capable of only the most rudimentary movement, today's highly mobile units are equipped with sensors and computers.

Fun and games. Naturally, there is no clear-cut definition for amusement robots, and they differ considerably from the regular industrial robot in both looks and purpose. In many respects,

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Teizo Fujita, president

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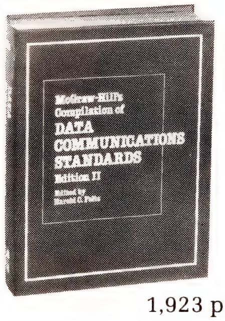

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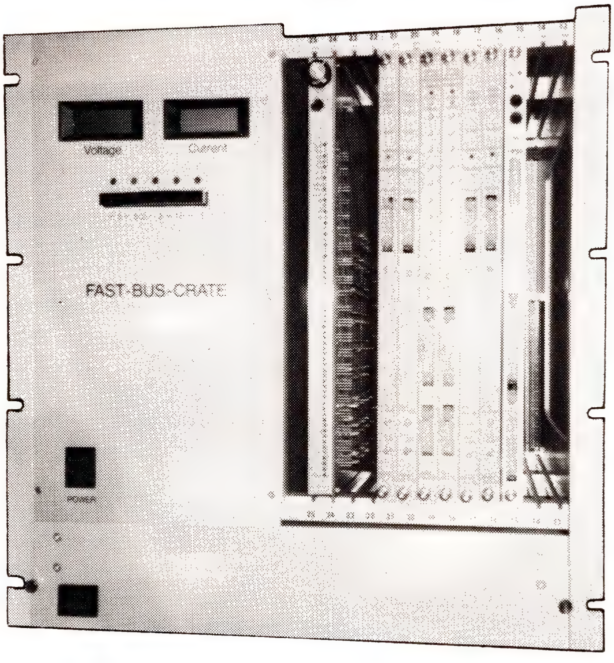

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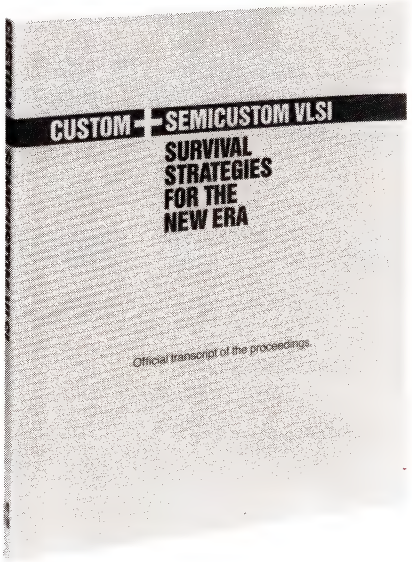
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the constituent technology is the same and future growth is anticipated.

The amusement segment of the market is estimated by the *Japan Economics Newspaper* to have amounted to roughly 5 billion yen in fiscal year 1984. What's more, that segment is receiving more and more attention as such giants as Kyocera and Sumitomo Electric Industries enter the market.

New applications. An unexpectedly large number of robot development areas outside of production processes are either in the conceptual stage or in early practical use. Robots in early practical use and their developers include:

- Concrete-spraying robots (Construction companies)
- Branch-cutting robots (Logging machinery manufacturers)
- Distribution-line robots (Power companies)

Robots in the conceptual stage and the organizations contributing to their development include:

- Mining tunnel repair robots (Coal Technology Labs.)
- Fish-catching robots (Fishing Association)

The Nomura Research Institute conducted a study on the use of robots in the non-manufacturing fields for the Japan Industrial Robot Association. The study identifed the types of non-manufacturing robots and the years during which each type will emerge. Roughly, the areas can be classified into three groups on the basis of their projected periods of maturation. The first group consists of application areas for which robots can be developed around 1987, and have one or more of the following characteristics in common:

- The performance of relatively simple, repetitive tasks, like cleaning tanks or spraying fertilizer.
- A relatively simple hand movement function.
- A low intelligence level as compared to the other application areas.
- A limited range of movement (no need for sophisticated mobile functions).

Development of those in the second group is forecasted for around 1989. These robots are thought to require a more sophisticated technology than those in group 1 in mobility, hand movement, and intelligence.

Those in group 3 are anticiapted to be developed around 1992 or later. The estimated term of their emergence has been pushed back by the fact that these require a level of performance that is equal to or above that of a human's.

It appears that these robots will attain a technological level allowing practical use beginning in the early 1990s, Nomura's study found. □

Focus on Iwatsu Electric Co.

Satoshi Nishonomiya, director

In 1950, Iwatsu Electric Co. Ltd. expanded its operations to include a new area of manufacturing test-and-measurment equipment. Up to then, the company had concentrated primarily on the production of telecommunications products and electrostatic duplication equipment.

The new endeavor met with remarkable success, particularly the production of high-performance oscilloscopes. Iwatsu initiated this project just after Tektronix had done the same in the United States, making it the second oscilloscope producer in the world.

Since its inception, Iwatsu's electronic test and measuring instrument division has played an important role in the field, not only as a producer of high-quality oscilloscopes, but also for digital measuring devices as well as custom-designed test and measuring systems.

Moreover, the components that make up all of our precision equipment, such as cathode-ray tubes, switches, and large-scale integrated circuits, are designed, developed, and manufactured in house, thereby giving Iwatsu total control over quality as well as enabling the firm to maintain product excellence.

We view the on-going challenge for better, more refined instruments for testing and telecommunications an exciting one, says Iwatsu's director Satoshi Nishonomiya. And considering our years of experience, past field-proven successes and numerous awards in the industry, it is a challenge we are well prepared to meet. Continual improvements in the performance of the equipment we make is another challenge Iwatsu anticipates with confidence.

As well, Iwatsu provides two kinds of software—applications programs for using Iwatsu systems and instructional software to help users understand all the possible technical applications for the equipment.

Looking to the future has always been a watchword at Iwatsu, Nishonomiya points out.

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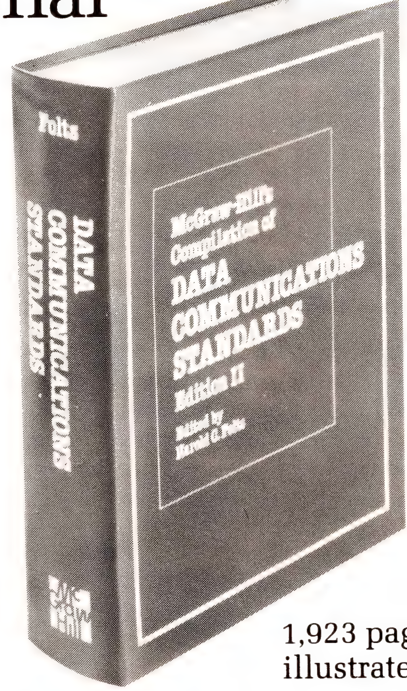
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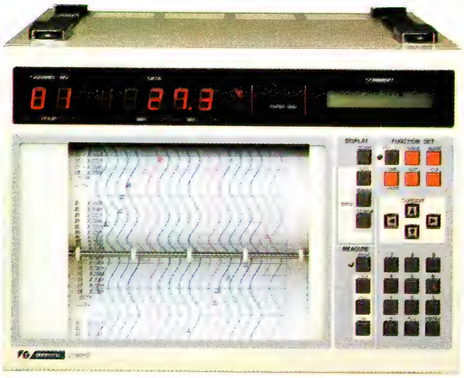

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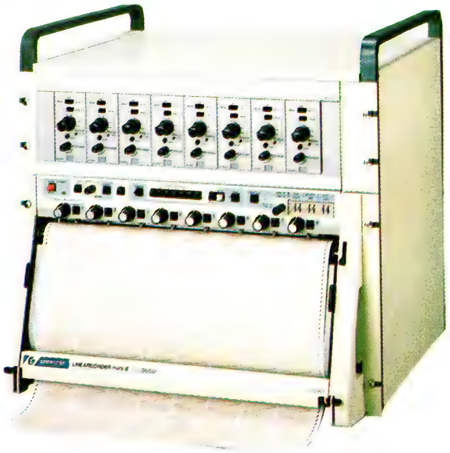

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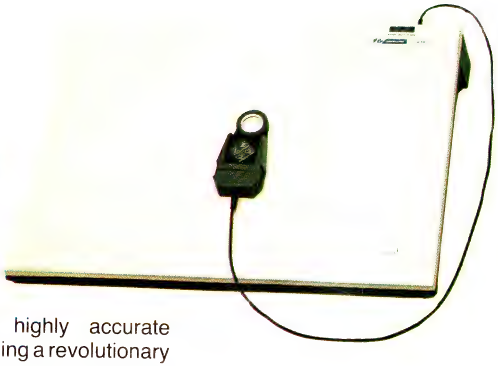

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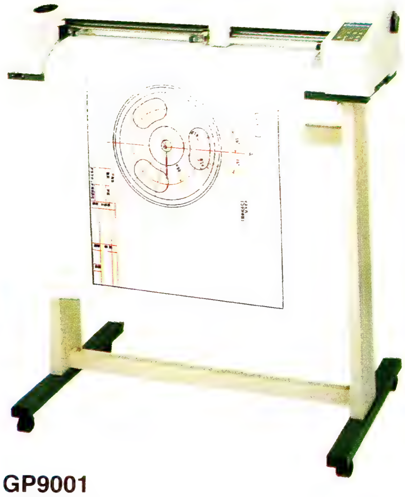

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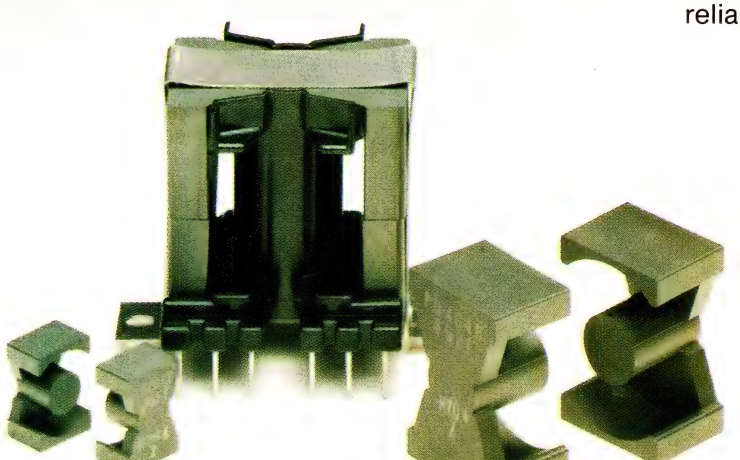

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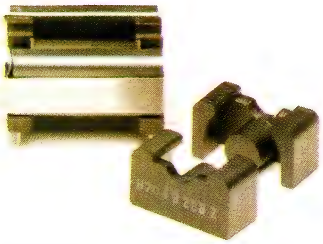

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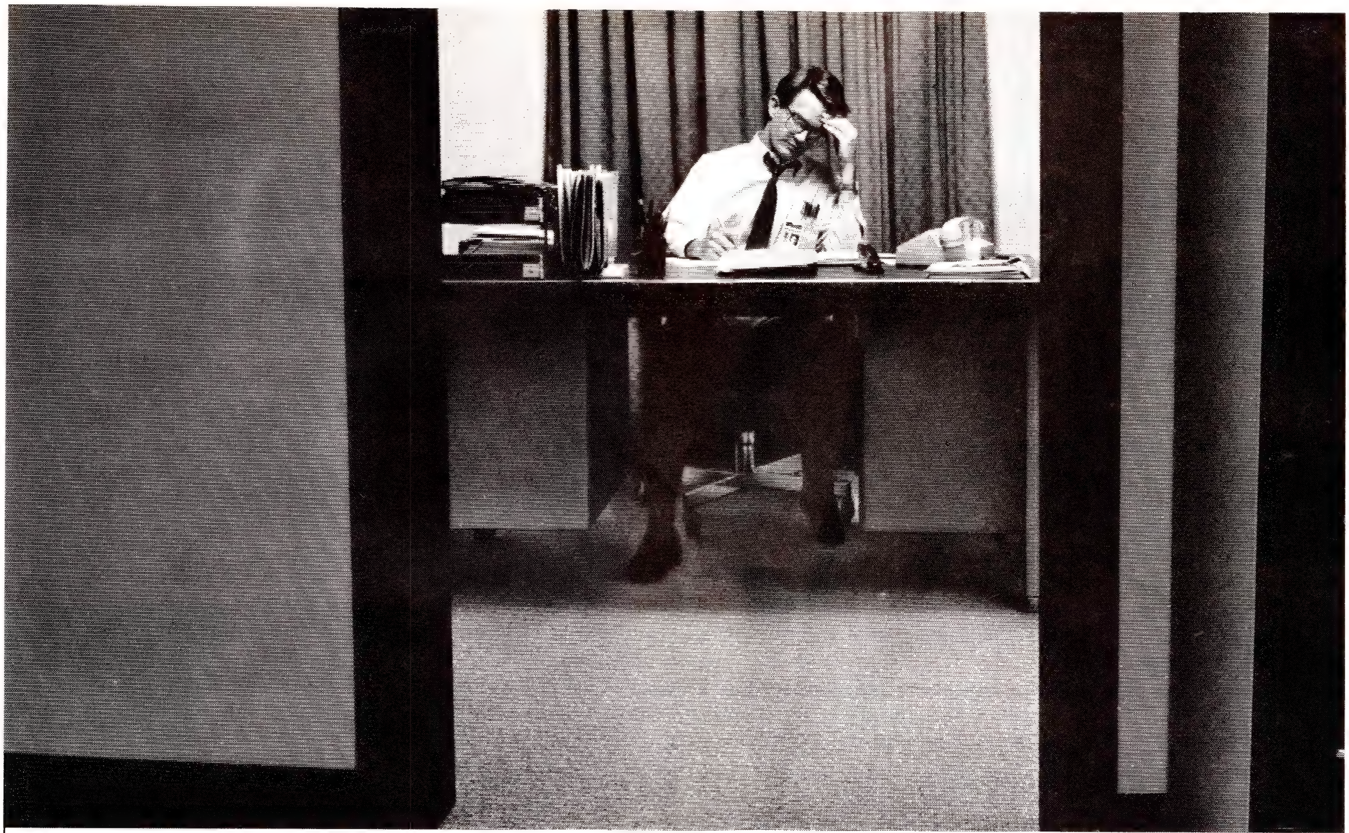

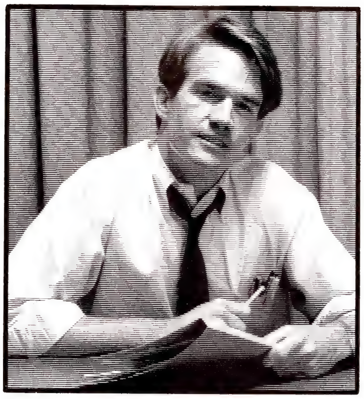

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"Something must be done about them." **Alfred North Whitehead, Philosopher and Mathematician**

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GERMAN COMPANY USES OPTICAL EXPERIENCE TO MOVE INTO THE SEMICONDUCTOR-EQUIPMENT MARKET

WETZLAR, WEST GERMANY

Long associated with the manufacture of microscopes and cameras, Ernst Leitz Wetzlar GmbH is working hard to transform itself into a highly visible supplier of leading-edge electronic analytical instruments. "We want to shed the image of being just a microscope and camera producer," says Ewald Bentz, manager of the Semiconductor Equipment Division. "We also want to become known as a high-tech company in the semiconductor field."

Since branching out into semiconductor equipment in 1981, the company has moved into the top ranks of producers of optical measuring and inspection equipment and systems for semiconductor manufacturers. It's scored annual growth rates averaging 30% during the past three years. Total sales in the semiconductor operations this year should exceed $40 million—"three times the amount of 1981 when we started," says Bentz. Now, to bolster its position in the U. S., Leitz has entered into a joint venture with Image Micro Systems Inc., Boston, to represent its interests in North America.

Leitz claims it has a 10% share of the roughly $400 million worldwide market for optical measuring and inspection equipment for the chip industry. This global market could grow to over $650 million by 1988, according to VLSI Research Inc., a market research company in San Jose, Calif. Leitz's success has come in the face of heavyweight competition from such companies as Nippon Kogaku K. K. (better known as Nikon) and Olympus Optical Co. of Japan and Optical Specialties Inc. of Fremont, Calif., and Nanometrics Inc. of Sunnyvale, Calif.

INNOVATIVE HISTORY. Leitz has a history of innovation. Founded in 1849 in this medieval Hessian town a few miles north of Frankfurt, it began by developing distortion-free eyepieces and lenses for microscopes and telescopes. In 1913, Leitz invented the 35-mm camera and brought it to market in 1925 as the Leica—a brand name that is better known, especially in the U. S., than the company behind the product. More recently, Leitz has come out with an advanced scanning acoustic microscope and a robot-controlled semiconductor-inspection system.

Leitz's move to chart a new direction was prompted by changing environments for its traditional products. Although one third of its roughly $250 million in worldwide sales last year was in cameras, competition, particularly from Japan, has reduced the company's profitability in that market. (The privately held Leitz won't divulge specific information on its financial performance.)

FAST-GROWING ALTERNATIVE. As for optical equipment such as microscopes and other gear for biomedical and analytical uses, business from big customers—scientific institutes, medical establishments, and schools—is often subject to spending restraints and budgets cuts. Thus Leitz had to look for fast-growing alternatives; it settled on optical measuring and inspection equipment for the electronics industry.

The Semiconductor Equipment Division exports about 85% of its output. It sells to virtually every major semiconductor market in the world from the U. S. and Europe to the Far East. Ten countries account for some 90% of its business, with the U. S. by far the biggest buyer.

Like many European suppliers, Leitz turned to the U. S. market because "we realized that the European market is too small for adequate growth," Bentz says. Last year, the U. S. semiconductor market accounted for about 40% of Leitz's optical measuring and inspection equipment business.

"It is not enough to just export equipment to the U. S.," Bentz emphasizes. "We must also be present there." To that end, Leitz established the joint venture with Image Micro Systems, late last year. Leitz-IMS Co., with a staff of 15, intends to speed up the flow of technical information to enhance the company's development capability.

Leitz-IMS will find out what U. S. customers want in new or improved equipment and then send those findings to Leitz's development center in Wetzlar. "A partnership relation with chip producers is essential to success," Bentz states. "As an equipment supplier, we want to become indispensable to our customers."

LONG TRADITION. One factor that has aided Leitz in its new business is its long-standing reputation in precision optics. "Although the semiconductor equipment market was new to us, we were familiar with the basic optics technology required," Bentz notes.

But tradition alone does not breed success. Other well-established companies specializing in optical equipment have not scored as well as Leitz has in new fields. Along with stressing product quality, Leitz keeps up with trends in chip technology, trying to foresee what's coming next and stay one step ahead of the market.

TRADITION. Ernst Leitz Wetzlar GmbH, known for the Leica camera, has moved into the field of high-tech optics.

For example, all Leitz equipment is designed to handle wafers up to 6 in. in diameter, which are rapidly becoming the industry norm. With its equipment based on modular construction, users can easily build complex automated measuring and inspection systems featuring up-times as high as 98%.

Customers testify to Leitz's emphasis on quality and its innovative prowess. "Sure, Leitz is not without competition and as is the case with any equipment, its systems can be improved upon," says an executive in the Manufacturing Engineering Division at Siemens AG in Munich. "But we value the equipment the company offers. That's why we are buying so much of it."

Annual growth has averaged 30% in semiconductor field

There are other factors in Leitz's success, such as sound business practices and a clear-cut strategy to reach the goals the company sets for itself. Though new in the semiconductor equipment field, the Semiconductor Equipment Division has strong support at Leitz headquarters. For example, it allocates the largest chunk of research and development funds—more than 10% of the division's sales—to the new activity.

Besides monitoring whether products conform to what customers want, Leitz management periodically reviews sales targets to see whether they are realistic in a given market environment.

Industry analysts cite still another factor. "Part of the success is that the division is run by a team of dynamic and relatively young people," says Winfried Arndt, a Frankfurt consultant. Many of them are academicians with advanced degrees in physics or engineering. Bentz, for example, is 37 and holds a doctorate in physics.

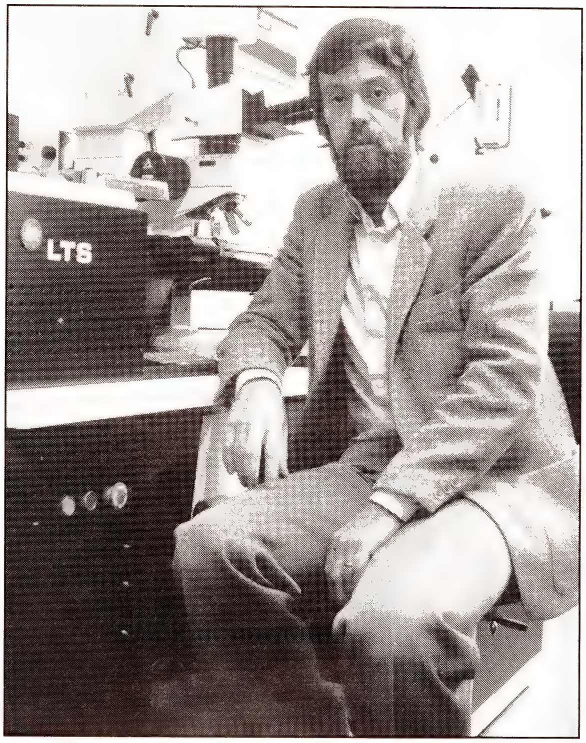
Leitz's service organization also plays a major role in the firm's success, observers say. Besides a total of 5,200 workers in its major markets, Leitz maintains a network of agents in more than 120 smaller countries where the division is not represented.

INVESTING. Given Leitz's engineering know-how and reputation for quality products, the Semiconductor Equipment Division's business may well grow at the annual average rate of between 20% and 25% that it has targeted during the next five years. Bentz believes this can be achieved even though the world's semiconductor industry is going through a serious slump. In anticipation of better times, many companies, particularly in Europe, are investing heavily in new plant and equipment for their chip operations, and Leitz is determined to cash in on these investments.

Exemplifying Leitz's innovative products is a microscope that, using ultrasound waves, lets the viewer look inside an object [*Electronics*, May 31, 1983, p. 88]. Based on the principles of scanning acoustic microscopy worked out at Stanford University, the Elsam (for Ernst Leitz Scanning Acoustic Microscope) produces an image of the internal structure of a chip on a cathode-ray tube. The microscope is the first commercial scope of its kind on the market.

The Leitz Inspection Station was the first robotics-controlled inspection station for 6-in. wafers when it came out in 1983, Bentz says. Incorporating an automatic focusing system, the station allows contamination-free handling of wafers.

Now in development is a fully automatic inspection station that combines with either a semiconductor layer-thickness or a critical-dimension measuring subsystem. With the latter, line widths below 1 μm can be measured with a repeatability of 0.02 μm or better, and measurements are operator-independent. *–John Gosch*



STRATEGY. Leitz must operate in the U. S., says Ewald Bentz, manager of its semiconductor equipment unit.

BOTTOM LINES

CAE SYSTEM SUPPLIER RAISES $6.2 MILLION

VIA Systems Inc., North Billerica, Mass., completed a new $6.2 million financing package that consists of $3.2 million of venture capital and a $3 million line of credit with the Bank of New England. The company, which makes computer-aided-engineering, -design, and -manufacturing systems for very large-scale integrated and hybrid circuits, says the funds will be used to expand its product line. "This new round allows us to put forth a major effort to maintain and increase our lead in the growing ASIC [application-specific IC] and hybrid markets," a representative says.

BUSINESSLAND GETS NEW LINE OF CREDIT

Having decided to delay its plans for a public offering of debentures, Businessland Inc. has increased its line of credit with the Bank of America to $50 million from $40 million. The San Jose, Calif., company says the offering of $35 to $40 million in debentures was delayed pending further review of market conditions. The funds will "allow Businessland to continue its expansion plans into new and existing markets," says Businessland president David A. Norman. The company, which earned $239,000 on revenue of $267.4 million in fiscal 1985, owns and operates 61 Businessland Centers in 18 states.

RAYTHEON INVESTS IN LISP MACHINE

Calling it the first of its new venture investments, Raytheon Co. says it plans to invest $4.5 million in Lisp Machine Inc., the Cambridge, Mass., developer of machines for use in artificial intelligence. Raytheon Ventures, the group that is making the investment, said the minority position in Lisp Machine typifies the investment opportunities that the company is pursuing. Raytheon said it has no plans to acquire Lisp Machine.

MEDIA MAKER CLOSES PRIVATE FINANCING

Charlton Associates, Irvine, Calif., a manufacturer of 5¼-in. rigid disks, has completed a round of private financing that netted $7.1 million. The privately owned Charlton said this fourth private stock placement brings its total financing to $26 million. Proceeds from the financing will be used to expand manufacturing capacity, develop new products, and pay off company debt, a representative says.

PLAYERS

CIRILLO SEEKS BETTER GaAs FABRICATION GEAR

MINNEAPOLIS

If ultrafast digital gallium arsenide integrated circuits are ever to become a production reality, there must be major improvements in the molecular-beam-epitaxy equipment now used to fabricate them in the lab. "We're constantly struggling with how molecular-beam-epitaxy technology is going to evolve over the next couple of years to make it production compatible," says Nicholas Cirillo Jr., supervisor of the Gallium Arsenide Digital Electronics section of Honeywell Inc.'s Physical Sciences Laboratory.

CALL IS OUT. Nicholas Cirillo wants better epitaxy equipment for GaAs ICs.

Cirillo, 36, led the Honeywell team that recently laid claim to the record for the fastest transistor yet demonstrated [*ElectronicsWeek,* May 13, 1985, p. 19]. His name appears on the patent filed on a Honeywell process that could one day lead to complementary GaAs circuits that will capitalize on the material's inherent speed without giving up low power consumption [*Electronics,* July 1, 1985, p. 16].

However, both developments depend upon molecular-beam epitaxy for heterostructure device fabrication. If the Honeywell innovations are ever to find their way out of the laboratory, a new generation of production-worthy machines must emerge, Cirillo says.

Improvements are essential in the process's price/throughput performance and in reliability, among other parameters. A typical $1 million molecular-beam-epitaxy machine today can produce perhaps 300 to 500 wafers per year in a research environment, Cirillo says. If heterostructure GaAs devices are to become cost effective for production, he figures that molecular-beam-epitaxy throughput must be tripled, or else the price of an molecular-beam-epitaxy machine must be cut two thirds. Reliability must also be improved, Cirillo says, because current-generation machines are down about 25% of the time.

MATERIAL REWARDS. Cirillo, who was named to his position in April, joined Honeywell's GaAs digital IC team in 1983. His interest in heterostructures prompted the move. Heterostructure research in the III-V compounds such as GaAs is more advanced than in II-VI compounds such as mercury cadmium telluride, his earlier research specialty.

Before making the move to GaAs, he spent five years working with the II-VI material for thermal-imaging applications, first at the Army's Night Vision and Electro-Optics Laboratory at Fort Belvoir, Va., and later at Honeywell beginning in 1981. He earned his doctorate in physics from Georgetown University in 1979.

Cirillo notes that Honeywell and other molecular-beam-epitaxy users are working closely with manufacturers of the equipment to develop production systems. "Already, we're seeing machines with larger source ovens that can handle up to 3-in. wafers," he points out. Advances are also being made in molecular-beam-epitaxy growth techniques that do not require an indium backing on the wafer. Though the indium allows uniform heat distribution over the wafer during growth, it makes for a cumbersome and time-consuming process that burdens machine throughput.

"Maybe I'm optimistic, but my own feeling is that you'll see what I'll call the manufacturing generation of molecular-beam-epitaxy machines being developed over the next two years, and that you'll see first deliveries to industry in about three years." *–Wesley R. Iversen*

SHAW CAPITALIZES ON MARKET SHIFT

COSTA MESA, CALIF.

Peter J. Shaw believes the days of the graphics computer are over. The market now belongs to desktop computers in which graphics is just one of many integrated features. So the 39-year-old president of Genisco Computers Corp., a pioneer in raster-based displays, is repositioning his tiny company—with $12 million annual sales—to exploit the markets he considers strongest.

Shaw's targets are military command and control, seismic work, and computer-aided design and manufacturing where three-dimensional displays are needed. His company's first new hardware comes out this month—a line of distributed color work stations debuts, along with data-base software.

Graphics terminals, featuring specialized controllers and carrying premium prices, were hot products from 1977 to 1982, and the companies designing and selling them occupied a glamour niche for investors. Shaw names as examples Ramtek Corp., Lexidata Corp., and Megatek Corp. (the San Diego company that Shaw once headed as president and chief executive officer).

But in 1982, says Shaw, "something changed, and that was the work station-personal computer phenomenon." Computer graphics, which had been a separate business, "became just another part of the computer, like disk drives and terminals."

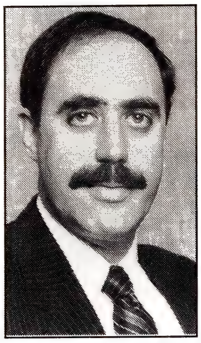
SAME STUFF. A further tipoff that a graphics processor now differs little from a microcomputer can be found by comparing their components. "They're virtually the same parts," Shaw notes, so it makes no sense to ask a customer to pay an elevated price for the graphics unit. "The economics just falls apart."

Many competitors agree with Shaw's analysis of the state of computer graphics. For example, Shaw's successor as Megatek president, Paul E. Huber, says, "We're saying basically the same thing. We came to that conclusion at least a year ago." Megatek sees a different way to cope, however. Huber thinks major computer firms with the largest resources will dominate the work-station market; smaller companies will not be able to compete successfully.

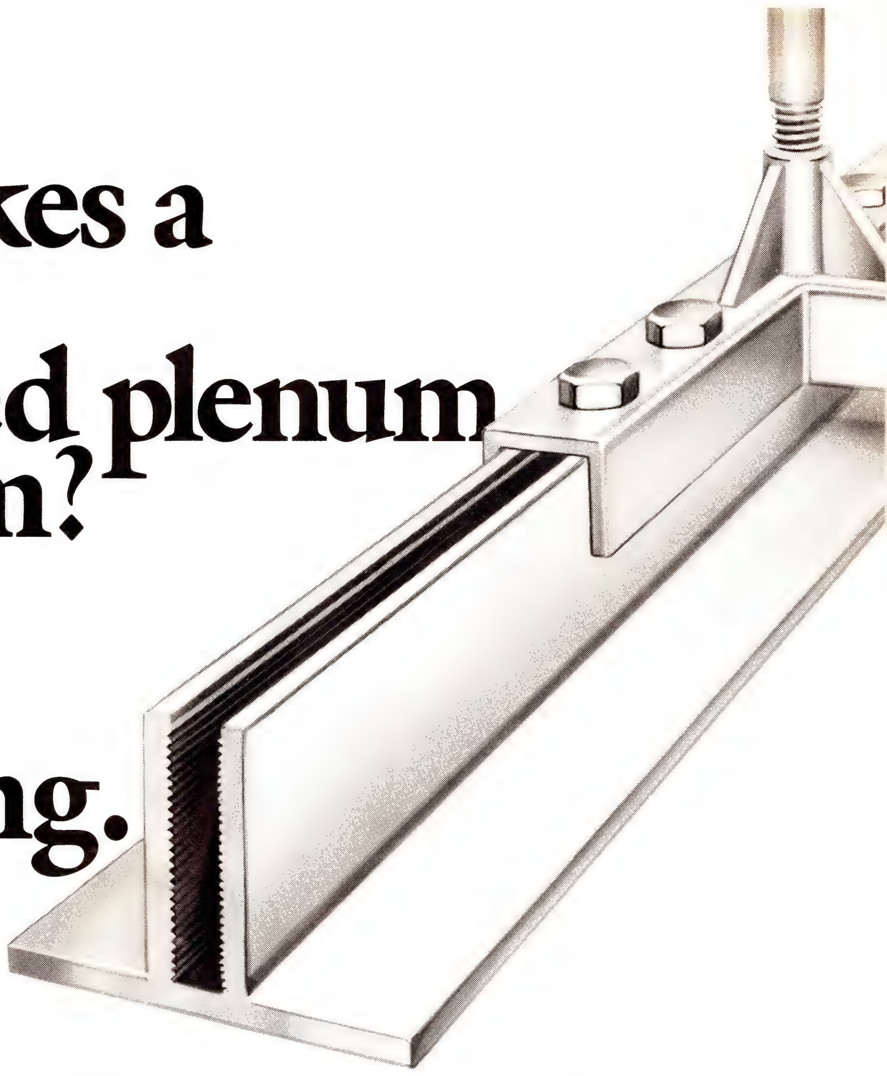
Graphics-equipment suppliers are still sorting out the implications, "and some still are not quite sure what is going wrong," Shaw adds. He refers to those firms as "graphics boutiques, as opposed to large computer companies."

Shaw has solid credentials for interpreting this business. Between leaving Megatek in 1982 and joining Genisco in December 1984, he founded Syte Information Technology. He says the company was preparing a superminicomputer that was ahead of its time, but "our investors pulled the plug on us" before Syte could demonstrate it. The startup went under last year.

Shaw advises would-be computer graphics suppliers to do what he plans to do with Genisco: create packages for the needs of customers and integrate them into system hardware. He sums it up succintly. All the supplier has to do is just "point them [the packages] toward the right applications and then fine tune." *–Larry Waller*


ERA OVER. Genisco's Peter Shaw says the graphics-processing terminal is dead.

What makes a superior pressurized plenum clean room?



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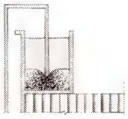
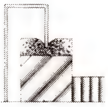


Dual seal



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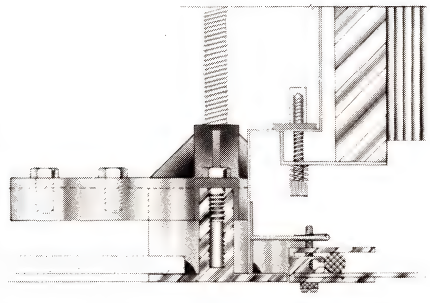

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HERE COMES A NEW BREED OF ION IMPLANTER

FULLY AUTOMATED SYSTEM HANDLES 6- AND 8-IN. WAFERS

Ion implantation is one of the most critical steps in fine-geometry integrated-circuit processing, and current implanters will not be able to handle the processing needs of the next generation of chips. Now a new fully automated ion implanter has been designed that overcomes these problems and will meet the processing needs of a wide range of ion implantations through the 1990s.

Applied Materials Inc., Santa Clara, Calif., (see related story, p. 89) considered all the problems encountered with conventional implanters in designing its Precision Implant 9000 and solved them by making a complete reassessment of every aspect of ion implantation and implanter design. The system nearly eliminates particulates and cross-contamination and quickly processes complex, very large-scale integrated circuits on wafers measuring up to 8-in. in diameter. It also provides complete and reliable repeatability over a wide range of currents, boosting throughput by about four times over previous generations of implanters.

In the ion implantation step, dopant ions, or impurities, are accelerated by an electric field and driven into the surface of a silicon wafer to give selective control of impurity atoms. These impurities accurately adjust the threshold voltages of MOS circuits. As chip geometries get finer, the need for more precise control and repeatability—implanting the same ions identically wafer after wafer—becomes paramount.

Current implanters are prone to scan-angle errors, which are products of the scan mechanism, and dose errors due to incomplete automation and control of the implant process. They also face problems of charging the silicon substrate and overheating the photoresist in the high-voltage environment.

Equipment engineers at Applied Materials' Implant Technology Division, Horsham, England, concluded that the current generation of implanters would be inadequate to handle procesing demands in chip-making, such as those required for CMOS and advanced submicron bipolar ICs in the late 1980s. The advanced CMOS VLSI circuits will require thinner gate oxides as well as more and shallower implants, particularly at high doses. Such ICs could require as many as 11 implants, four of them at high doses. This compares with about four doses in n-MOS processing with only one high-current dose required.

TECHNOLOGY TO WATCH is a regular feature of *Electronics* that provides readers with exclusive, in-depth reports from companies around the world on important technical innovations. It can cover significant technology, processes, or developments incorporated in major new products. The reports will also provide analyses of technical data so that readers can assess the impact of new developments. Louis Steen, general manager at Applied Materials' Implant Technology Division, and Michael Hall, project manager, led the effort described here.

The major objectives for the Precision Implant 9000 system were for high throughput at high dose rates, maximum reliability with complete automation, and minimum particulates and cross-contamination. In line with these objectives, the team set such goals as implant uniformity better than 0.75%, a maximum wafer temperature of less than 80°C, a voltage range of 10 to 180 keV, and beam currents from 12 to 30 mA and dose range from 10^{11} to 10^{18} ions/cm. They also sought a wafer-size capability to accommodate 3-, 4-, 5-, and 6-in.-diameter types as well as a capability for future 8-in. wafers.

As the first fully automated ion implanter, the Precision Implant 9000 features automatic handling as well as complete closed-loop control of the ion source and of the target chamber scan. A distributed-intelligence architecture allows the system to diagnose itself. More than 500 data points are monitored continually during operation.

The unit has no controls; instead, the user enters commands

1. A LIGHT TOUCH. Applied Materials' Precision Implant 9000 has no controls or knobs on its main unit. Instead, the operator uses a light pen to control all commands and recipes from an external color video screen interface. The system can also operate unattended.

with a light pen to either an external terminal (Fig. 1) or a terminal built onto the main equipment itself. The system can run unattended.

Current implanters simply use their computers as sequencers, with no closed-loop control. Changing the process requires a skilled engineer to reprogram the unit. With the 9000, a process engineer needs only to specify the recipe by three factors: species—such as singly or doubly charged elemental ions (usually boron) or molecules such as boron fluoride—dose, and energy.

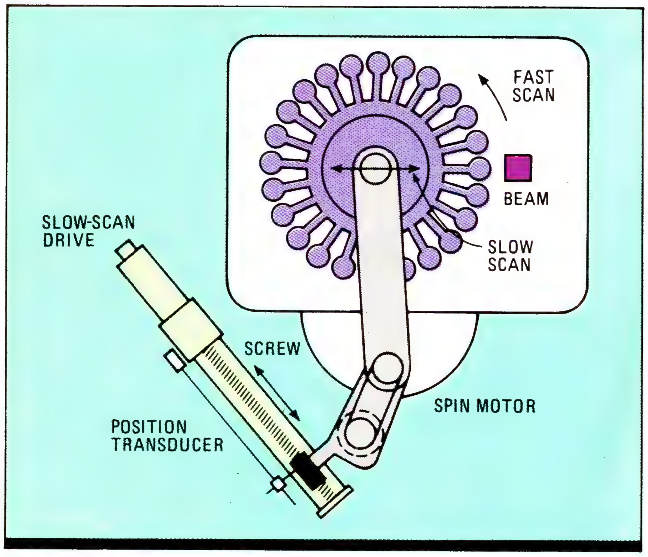
A LIGHT TOUCH

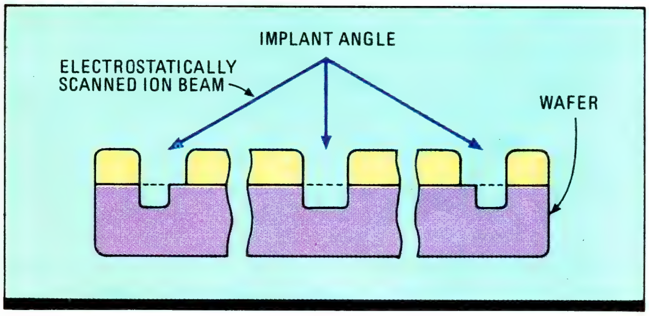
The unit's distributed intelligence system, known as Light Touch, then takes over. Consisting of a video display, a human-interface computer, a machine-interface computer, and a fiber-optics loop controller, Light Touch sets up the beam line, calculates scanning parameters, verifies the accuracy, and monitors and controls the implant process continually.

In addition, the automation system keeps the beam current from drifting. Maintaining a stable beam is critical to ensuring repeatability and accuracy. Light Touch maintains absolute control over the ion source, using several control loops to ensure beam stability over the current range. The implant is always the same regardless of the ion source and beam-line parameters used. The result is a system with dose uniformity and process repeatability of better than 0.75%, even on large-diameter wafers.

The new Applied Materials machine is the first implanter designed for 6- and 8-in. wafers. Current ion implanters' scan parameters, beam sizes, and wafer-loading quantities are suited for 4- and 5-in. wafers. These implanters can process a batch of 8 to 10 of these smaller wafers; the 9000 can process 6-in. wafers in batches of 25—a fundamental increase in throughput. In addition, the 9000's scan parameters have a built-in overscan capability that easily permits it to accommodate future 8-in. wafers. Current implanters are pushed to their limits to handle a 6-in. wafer.

2. DUAL MECHANICAL SCAN. Unlike current ion implanters, the 9000 has a dual mechanical arrangement that scans in a rotary direction at fixed speed and along the x-axis at a variable low speed.





3. SCAN ANGLE ERRORS. The X-axis electrostatic scan falters with large wafers and small geometries. A large change in deflection angle can change the implanted depth of the species and cause shadowing.

All current implanters use a combination of a rotary mechanical scan and an electrostatic scan in the X axis to display the ion beam across a wafer. The 9000 departs from this scheme with a dual mechanical scan combining both fast and slow scan speeds. (Fig. 2).

The large 25-wafer platform rotates at a constant speed of 1,250 rpm, while a slow mechanical scan in the X axis varies from 10 to 0.25 cm/s. This slow scan takes the place of the electrostatic scan. The slow scan's speed is a function of implant parameters—it is controlled by a closed loop monitored by the implanter's computer system.

An electrostatic scan is not uniform (Fig. 3). As the beam is scanned across a wafer, its angular deflection changes. Small geometries and large-diameter wafers increase the amount of deflection. With a change in angular deflection, the implant depth can vary with the position of the scan and can cause shadowing of the implant at steep angles. With Applied Materials' slow scan, a constant deflection angle caused by moving the wafer in a rectilinear motion eliminates these problems.

The 9000's dual mechanical scanning system produces a large beam, a large scan area, and a fast scan speed of the wafer platform. The fast scan speed in turn results in a lower wafer temperature and reduced surface charge.

The dual mechanical scan ensures accuracy of the implant. As a further boost to accuracy, the system uses a planar heat sink in place of the conventional dome-shaped heat to present a uniform wafer surface to the scan.

LOW-PARTICULATE DESIGN

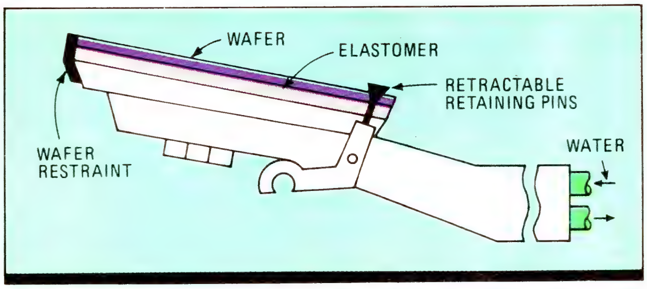
Process engineers agree that today's implanters introduce unacceptable levels of particulates and cross-contamination. A primary objective of the Precision Implant 9000 was to keep these troublesome characteristics to an acceptable level through careful design of the wafer-handling system, the scanning system, the pumping system, and the beam line.

The current generation of ion implanters loads and removes wafers in a nonvacuum environment and in a horizontal plane; both factors tend to increase particulates. In the Applied Materials system, the entire handling process takes place in a highly controlled vacuum, with the wafers held vertically. In such a position, particulates simply fall off the wafers as they are being loaded and removed and thus their presence on the wafers is effectively reduced.

To further reduce particulate stirring, the vacuum load lock incorporates controlled pump and fill cycles. Because all loading and unloading (from a 25-wafer cassette to the 25-position wheel) is done through the load lock, the target chamber never needs venting between runs. All actuators and drive mechanisms are located outside the vacuum and are sealed either with ferrofluidics or magnetic couplings to eliminate particulate-generating mechanisms.

In current implanters, wafers are clamped onto a platen or carrier during implantation. Clamping causes several major defects, including contamination, generation of particles, stress damage, shadowing, and lost implant area. To get around this, Applied Materials' designers went to an elegant, completely planar, clampless design that holds each wafer on its individually cooled paddle by centrifugal force (Fig. 4).

Still another way the Applied Materials system maintains its low particulate level is through its installation in a clean room (Fig. 5). Clean-room access to the machine is limited to the load-lock chamber and the video control screen, from which all phases of the process are controlled. The system is



4. WAFER PADDLE. The new implanters paddles are multifunction units. They secure the wafers without the use of clamps. In addition, a water-cooled heat sink built into the paddle keeps the wafer's surface to below 80°C with 4 kW of beam power.

flush mounted through the clean-room wall with a minimum of disturbance to the clean-room's laminar flow. Maintenance is done outside the clean room.

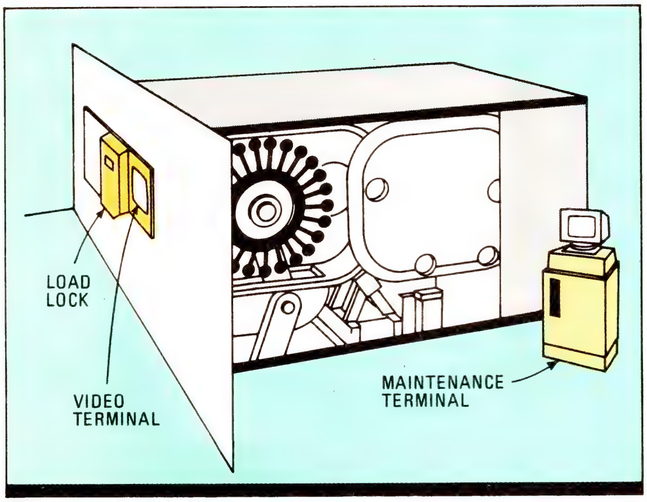
Cross-contamination—that is, any trace from a previous dopant operation in the apertures—in a multisource ion implanter is a serious problem, resulting in unwanted downtime while the apertures are cleaned. The beam line of the new implanter has been designed to eliminate contamination by the beam. Sputtering traps in the flight tube, dedicated resolving apertures for each species, and the absence of wafer clamps ensures minimal species cross-contamination.

THE FLEXIBILITY FACTOR

"The 9000 is a major step forward over the current generation of implanters because of its much higher degree of process flexibility," says Thomas Bowman, director of strategic marketing for Applied Materials. He notes that most users dedicate their machines to one of three areas—medium-current, high-current, or low-energy implants.

The 9000, with an energy range of 10 to 180 keV, is stable and repeatable over the entire range; the current generation of machines have process problems when not operated in their optimum ranges. For example, the 9000 can implant arsenic or phosphorus ions at a 30-mA level, implant boron ions at 11 mA and 20 keV, or boron at 6 mA and 10 keV (for shallow implants). The new implanter has three to four times more useful current than other units.

Because of its flexibility, the new system requires fewer machines to do the range of implants on an IC-processing line. With the trend toward application-specific ICs, frequent changes in implant specifications from design to design will demand a more flexible machine such as the 9000 rather than a group of dedicated machines.



5. THROUGH THE WALL. The Precision 9000 is installed so that only its load lock and a video terminal are mounted through the wall of a clean room. All maintenance and programming are done outside of the clean room. This installation minimizes particulates.

Another facet of the 9000's flexibility is its ability to automatically change over to new implant conditions such as different dopants or current levels. This is primarily a result of the high degree of automation, such as closed-loop beam control. For example, current implanters are extremely cumbersome to change and must be cleaned, followed by a manual changing of the aperture. This operation often takes several hours. The new implanter automatically changes the source, tuning of the beam, and the resolving apertures in 30 min.

Existing ion implanters' inherent unreliability decreases their uptime. Recognizing this, Applied Materials' design team attacked this problem in the design phase. Beam current was derated from 45 to 30 mA; the wheel, scan, and loader mechanisms were designed with extremely simple mechanisms; and diagnostics and monitoring were built in.

However, building the extensive computer and sensing circuitry to survive and operate in the high-voltage environment (up to 180 keV) required an innovative solution. David Reis, technical marketing engineer, notes that 30% of the downtime experienced by current implanters comes from failures and errors caused by radiated electromagnetic interference in their high-voltage environments. Applied Materials found the solution to the problem in the use of fiber optics and electromagnetic-interference shields. The Light Touch system is housed in a fully shielded enclosure that is isolated from the implanter by fiber optics.

Localized data-acquisition units containing microprocessor intelligence are distributed thoughout the implanter in close proximity to the hardware they control. These units are contained in small shielded boxes within the implanter. They transmit data over fiber-optic cable to the central control console. A microprocessor-based loop controller continually monitors the status of all units on its loop.

MAINTAINING THROUGHPUT

The factors that Applied Materials' engineers addressed in designing the Precision Implant 9000 all contribute to the ultimate goal, which was to maintain the full throughput of the machine. Because throughput relates directly to the current of the ion beam, two problems had to be solved in the new implanter.

Most current machines must be derated below their rated ion-beam current because of photoresist burning due to insufficient cooling and due to charge build-up on the wafer. Heating the photoresist causes it to distort, which in turn results in positional errors in the implant. Excess charge, on the other hand, can actually blow thin-oxide gates.

Applied Materials' design team didn't want a brute-force solution that required an oversized water-cooled heat sink, so it concentrated on keeping the wafer-and-paddle arrangement as cool as possible. The team decided to do this designing in a large beam. This results in smaller current per unit area than in current machines.

In addition, by being subjected to a much higher scan speed, each wafer on its individual paddle encounters the beam for a fraction less time during each revolution. This allows each wafer to cool down during its off time.

Finally, each small-area paddle is water cooled by its own efficient planar heat sink. This arrangement allows four to five times the power on a wafer than on current implanters. It holds the wafer temperature to under 80°C for up to 4 kW of beam power, which in turn allows the full-rate beam current of 30 mA.

Current implanters use a small-beam, slow-scan method, which results in a high charge per unit time. Then various schemes are used to reduce the charge. The 9000, with a large beam and high speed scan has a greatly reduced charge per unit time, which has little or no effect on the processing. ☐

GETTING R&D HELP FROM OTHER NATIONS

Electronics companies have always been able to tap their governments for research and development money. But it's rare that a company gets funds from a foreign country. Applied Materials Inc. has done so twice.

Both its overseas subsidiaries—one in Great Britain and one in Japan—received hefty sums from those governments. In fact, the British government provided one third of the development costs for Applied's Precision 9000 ion-implantation system (see related story, p. 86). "We try to operate as an international company in every sense of the word," says James C. Morgan, president of the Santa Clara, Calif., company.

Applied Materials was founded in 1968 to produce high-grade silane gases for thin-film deposition. It soon decided there were no production systems on the market that could do a good job of depositing films. So in 1969, the company introduced epitaxial reactors and chemical-vapor-deposition systems for semiconductor fabrication. In 1981, Applied introduced a plasma-etch system with which it claims to have gained the lion's share of that market.

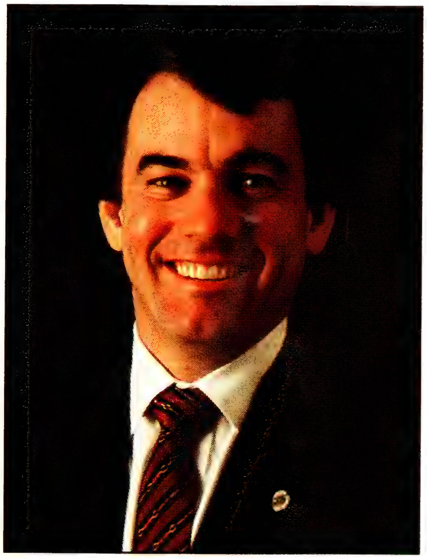
UK CONNECTION. Applied got into ion implantation in March 1980, when it bought rights to high-current implant technology from Lintott Engineering Corp., an aerospace engineering and manufacturing company in Horsham, England. Lintott had worked closely with Britain's Atomic Energy Authority on ion-beam physics development, and was already Europe's major producer of implanters. This technology started Applied on its way to developing the Precision Implant 9000, which will sell for about $1.8 million. The implanter was developed at Applied Implant Technology, the company's British subsidiary.

After canvassing potential customers about future needs in ion-implant technology, the company realized it would be difficult to fund such a project alone, given the state of the economy.

"We needed to get the financing off the balance sheet," says Morgan. So Applied began working with Britain's Department of Trade and Industry to obtain funding under the department's Microelectronics Industry Support Program. Applied Implant received a grant for some £1.6 million—about $3.5 million. That money represented one third of the implanter's total funding. Another third came from private investors, who the company has since bought out.

The grant's only stipulations were that the company had to remain in the field of microelectronics and conduct the product's development and three years of manufacturing in the UK. At present, some 125 engineers and support technicians, most of them British, are employed by the UK division.

INDUCEMENT. The fact that Lintott had spawned the technology didn't hurt Applied's chance to get the money, according to Louis Steen, general manager of the Applied Implant Technology subsidiary, who moved from the parent's Santa Clara headquarters to Horsham two years ago to run the operation. "The preservation of an industry which had been successful in the past had added impetus," Steen says. "They [the British government] could see the handwriting on the wall, that they needed to provide some inducement for us not to take their key guys back to the States and develop it there.



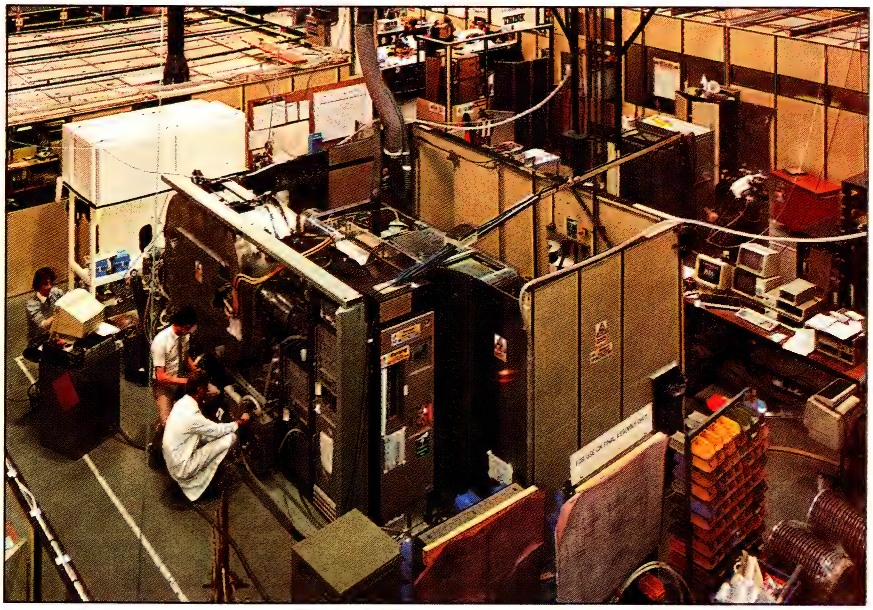
WORLD CLASS. James Morgan wants an international profile for Applied Materials Inc.

"But the main thing was that the project met their objectives. If it hadn't, no amount of other emotional issues would have changed the outcome. They are a very pragmatic group."

Applied Materials Japan Inc.'s technology center, which opened last October in Narita, was the first wholly foreign-owned company to receive funding—a $3.4 million loan—from the Japan Development Bank, an agency of the Japanese government responsible for fostering industrial development within Japan. More than 50 foreign companies applied for the loan, but only Applied got the nod. Now one third of its sales come from Japan.

Along with technology centers in Horsham and Narita, Japan, the company has sales and service offices in the People's Republic of China, Korea, Hong Kong, France, West Germany, and the Netherlands. "It's a heavy structure to support, but once it's to scale, it's very effective," Morgan says.

Applied's objective is to reach a 30% market share in ion implanters in two years. Market research company VLSI Research Inc. estimates the total market will be worth $562 million by 1987. "You bet we can do it," says Applied's Steen. "People didn't think we could do it in the dry-plasma-etching business either, and we did. We entered the market with zero, and now we have 30% to 40% market share. There's no reason why this product shouldn't do the same thing." *–Denise Caruso*



INDUSTRIOUS. Applied Implant Technology developed the Precision Implant 9000.

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SUPERFAST ICs HERALD NEW SUPERCOMPUTER ERA

BY 1990: GATES MADE OF DENSER BIPOLAR, GaAs, AND SUPERCOOL CMOS

by Tom Manuel

In the fast-moving world of supercomputing, tomorrow's technology can never come too soon. The next generation of supercomputers and minisupercomputers won't come off the drawing boards until next-generation integrated circuits appear. So chip makers and computer makers alike are feverishly at work on a new round of ICs that stretch the state of the art. They also are exploring the uncharted territory of the exotic device technologies that lie beyond faster, denser silicon and gallium arsenide. Should they succeed in perfecting their dream chips, the benefits will spill over into every computing application.

For the near term, the three most promising technologies are fast CMOS cooled to the liquid nitrogen temperature of 77 K, denser bipolar ICs, and some early use of GaAs. New gate arrays in all three technologies will play a significant role through the end of the decade.

In the longer term, several more exotic device technologies will be competing for the limelight. But these exotic devices—fabricated with such processes as molecular-beam epitaxy, complementary GaAs, gallium-aluminum arsenide high-electron-mobility transistors, and Josephson junctions—remain some distance from commercial reality. HEMTs, superfast experimental GaAs-AlGaAs transistors that switch in picoseconds and generate little heat, are particularly interesting. They are considered superior devices because their electron mobility is higher than MOS, bipolar, and even today's GaAs devices, which deliver superfast switching speeds on the order of tens of picoseconds, and they generate less heat than bipolar devices.

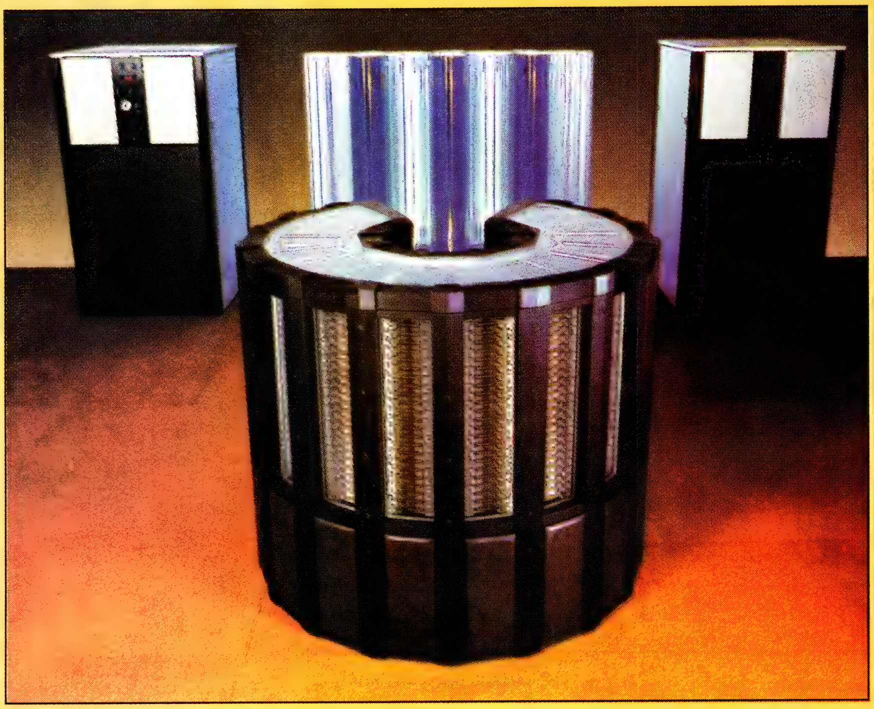
An HEMT is also called a MODFET (modulation-doped field-effect transistor), TEGFET (two-dimensional electron-gas FET), or SDHT (selectively doped heterojunction transistor)—each descriptive of a different aspect of the device. HEMTs have been made in the laboratory, but no one has developed an IC manufacturing process for them yet. In Josephson junctions, too, a breakthrough in production techniques is needed.

HOW CRAY KEPT THE 'BIGGEST AND FASTEST' TITLE

The Cray-2 is Cray Research Inc.'s latest bid to keep in the family the title of fastest and biggest commercially available computer. To keep the title, the Minneapolis company has capitalized on the state of the art in bipolar technology, packaging techniques, and MOS memory technology.

The Cray-2 has a clock cycle of 4.1 ns, the fastest time of any commercially available system. It has four background processors and one foreground processor. The Cray-2's 256 million words (64-bit words, 2,048 megabytes) of directly addressable common memory is about an order of magnitude larger than offered on other systems. The 16-gate emitter-coupled-logic array and 256-K MOS memory chips are mounted in a three-dimensional plug-in module with an 8-by-8-by-12 configuration of circuit packages.

The system has 320 of these modules for an integrated-circuit population of about 240,000 chips, nearly 75,000 of which are memory. Eight printed-circuit boards form the module structure, and circuit interconnections are made in all three dimensions. Each module is about 40% ICs, measures 1 by 4 by 8 in., and consumes 300 to 500 W of power. The modules plug into 14 towers, each 14 in. high, arranged in a 300° arc. A closed, 200-gallon cooling system circulates an inert fluorocarbon cooling liquid directly over the chips.



Speedy bipolar technology has stayed out in front, but it has the disadvantage of high power dissipation, which limits IC densities and requires elaborate packaging and cooling for large bipolar systems. Today's supercomputers are built with bipolar emitter-coupled-logic circuits—until recently, the fastest circuits available in the merchant market.

But supercomputer makers are beginning to substitute relatively fast, very dense MOS ICs for bipolar chips in main memories, because of their superior price-performance ratio and lower power dissipation. CMOS, the high-density low-power star in the IC firmament, is being used much more in both logic and memory circuits in supercomputers. Some of the minisupercomputers [*Electronics,* July 29, 1985, p. 26 and June 17, 1985, p. 31] and at least one new supercomputer, the ETA^{10} from ETA Systems, are being built with very large-scale-integration CMOS gate arrays. Moreover, some GaAs circuits are ready or nearly ready for market.

Cray Research Inc., Minneapolis, is working with GaAs for use in its Cray-3 Computer System, the follow-on product from the Cray-2 announced in June (see "How Cray kept the 'biggest and fastest' title" and Fig. 1). The company will say only that it hopes to execute the Cray-3 in GaAs. Cray has its own GaAs fabrication facility for producing prototype circuits. It is also working with outside vendors.

BIG CMOS GATE ARRAYS

The latest very dense, high-speed CMOS gate arrays are excellent candidates for the logic portions of supercomputer and minisupercomputer systems. Fairchild Camera & Instrument Corp., Mountain View, Calif., claims a speed advantage over all competitors with its line of CMOS gate arrays aimed at high-performance applications. Because of their speed and reliability, the parts have achieved excellent penetration in the Japanese market, according to the Gate Array Division general manager, Lanny Ross.

The arrays implemented in Fairchild's 2-μm double-metal CMOS process currently range from 500- to 8,000-gate densities at speeds quoted and guaranteed at 50 MHz. Within the last three months, however, Fairchild has shipped several designs in this technology that run in excess of 80 MHz. The 500- to 8,000-gate parts have been available since January; next year, Fairchild will offer 12,000- and 15,000-gate arrays. High-performance bipolar gate arrays have been available longer, and by the end of the year, the Gate Array Division will introduce CMOS standard cells to broaden the company's line of application-specific ICs.

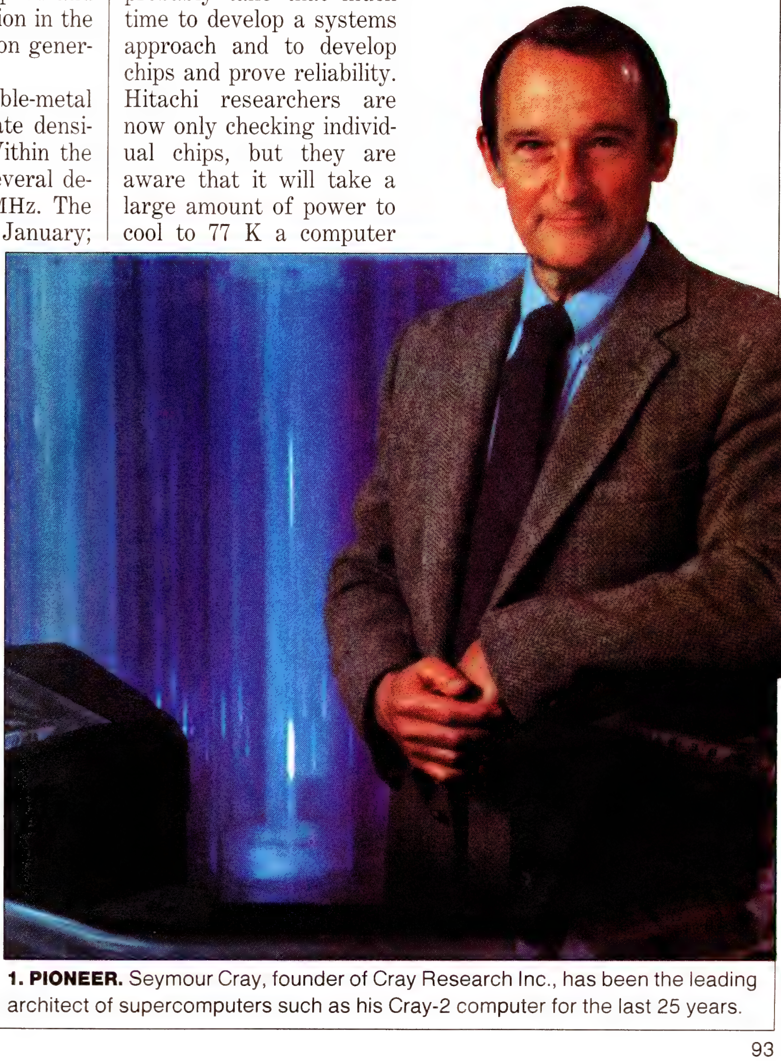
Another CMOS gate array that exhibits superior performance and high density is the one designed by supercomputer maker ETA Systems, St. Paul, Minn., for its ETA^{10}. The multiprocessor system, which performs 10 billion floating-point operations per second, will be ready next year. When cooled to 77 K, the 20,000-gate chip has internal delays of only 400 ps [*ElectronicsWeek,* Feb. 25, 1985, p. 18]. Even at room temperature, these arrays have a very respectable typical gate delay of 800 ps. Honeywell Inc., Minneapolis, is fabricating these arrays for ETA and could offer them in the commercial IC market—perhaps by 1986.

From Japan comes word about two more big CMOS gate arrays, both from computer makers. Toshiba Corp., Kawasaki, reports a 26,500-gate 168-ns array—bigger but much slower than the ETA part. The triple-level-wired Toshiba chip has four blocks of 6,000 gates each available for logic circuits. The remaining 2,500 gates serve as a wiring area for the four blocks. In a similar fashion, the ETA chip contains 22,000 gates, counting clock drivers, input/output buffers, a built-in functional test capability, and other fixed circuitry; 18,000 programmable gates are available in the matrix.

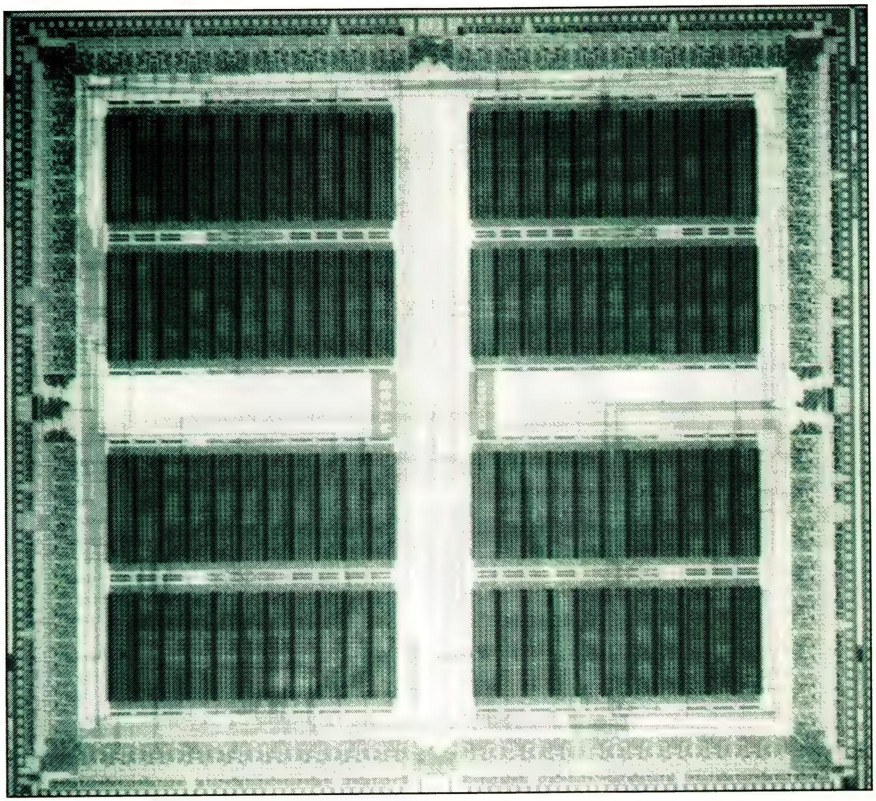
Not to be outdone, Fujitsu Ltd. has come up with a CMOS 1-ns 20,000-gate array series built with CMOS technology and having configurable on-chip 15-ns random-access memory. The array has 1.5-μm n-channel and 2.0-μm p-channel gate lengths and three layers of metallization. It is laid out in four quadrants, each of which is a 5,000-gate logic or 6-K memory block. The Kawasaki company produces three generic arrays with different logic-to-memory ratios—20,000 logic gates with no memory, 15,000 logic gates with 6-K of memory, or 10,000 logic gates and 12-K of RAM. Because high-speed central-processing-unit architectures require some memory, providing fast memory cells right on the logic chip should make the Fujitsu arrays popular among the makers of high-speed processors.

ETA achieves an effective doubling of the speed of its arrays by cooling them to 77 K, and any of the high-density fast MOS circuits can also be speeded up this way. Low-temperature CMOS devices show great promise for very high-speed VLSI because they provide both a speed advantage without an increase in power requirement and densities comparable to other competing devices.

At Hitachi Ltd.'s Central Research Laboratory, Toshiaki Masuhara, senior researcher, says that extrapolation of the characteristics of low-temperature CMOS chips to submicron line widths indicates that CMOS should provide the same speed as bipolar chips. This could be a technology for use perhaps 5 to 10 years in the future. Or it may have to wait until the year 2000, when line widths will have been reduced to 0.2 or 0.3 μm—small enough to attain bipolar speeds. It will probably take that much time to develop a systems approach and to develop chips and prove reliability. Hitachi researchers are now only checking individual chips, but they are aware that it will take a large amount of power to cool to 77 K a computer



1. PIONEER. Seymour Cray, founder of Cray Research Inc., has been the leading architect of supercomputers such as his Cray-2 computer for the last 25 years.



2. ECL ARRAY. The components of the 128-mm² emitter-coupled-logic 9,300-gate array from Siemens are arranged in four blocks surrounded by input/output buffers and bias drivers.

that consumes 100 W or more. That is the power that Masuhara assumes will be necessary for the chilled CMOS CPU and cache-memory portions—the main-storage, I/O-processor, and file-storage portions of the computer would operate at room temperature. Extrapolation of computer complexity shows that within a decade CPUs will have 10^7 gates. Thus they will probably have to be designed in CMOS whether or not they are cooled, says Masuhara.

Another example of low-temperature CMOS is an 8-by-8-bit multiplier developed by Hitachi and implemented in its Hi-CMOS III process (where both n- and p-channel MOS transistors have 1.3-μm gate lengths). It exhibits multiply times of 23.3 ns at room temperature, 11.3 ns at 77 K, and 8.0 ns at the liquid helium temperature of 4 K. When a combination of conventional CMOS and pulsed p-type-load static logic is used, the speed increases, but the power dissipation is much higher. The PPL multiplier speeds are 14.2 ns at room temperature, 6.6 ns at 77 K, and 5.8 ns at 4 K.

TWO TECHNOLOGIES, ONE CPU

Masuhara, who delivered a paper on these multipliers at this winter's International Solid-State Circuits Conference, says that though he describes two separate multipliers using different types of MOS technology, both technology types would be used in a single CPU. Although the pulsed p-type logic has a dc path and uses perhaps 100 times the power of CMOS, it is twice as fast and thus is suitable for critical paths in a processor. Charge-holding time of nodes increases at low temperature and thus the pulsed p-type circuits offer static operation—even though they are dynamic circuits. A node with a 1-s holding time at room temperature has a 10,000-s holding time at 200 K.

Hitachi also is perfecting its Hi-BiCMOS, a mixture of bipolar and CMOS processes to gain some of the advantages of both—fast bipolar speeds with CMOS's low power dissipation. The company has developed a version of Hi-BiCMOS that is ECL-compatible. The earlier mixed CMOS-bipolar devices, in which the bipolar portion is transistor-transistor logic rather than ECL, do not work well with ECL circuits because power-supply polarity and logic levels are incompatible.

A static memory made with the new ECL Hi-BiCMOS will provide the required quick access for designers of supercomputer main memories and superminicomputer cache memories at greatly reduced power dissipation, compared with ECL memory chips. The HM10480L part has a typical access time of 12 ns and a maximum access time of 25 ns. Operating power is only 350 mW—during standby, power falls to 220 mW.

In contrast, the standard ECL HM10480 has a typical access time of 15 ns (25 ns maximum), but a continuous power consumption of 800 mW. Power cannot be reduced during standby. This means that typical power dissipation of a memory board using standard ECL parts is more than triple that of one with the new parts, because almost all memory chips on a board are usually in standby mode.

Paradoxically, the HM10480L has a better yield than the all-ECL version because it is built with the larger dimensions of MOS. Only the I/O buffers and sense amplifiers are ECL; other peripheral circuits are CMOS and the memory array itself is n-MOS with gigohm load resistors—the same technology used in Hitachi's CMOS static RAMs. A 16-K ECL memory has about 70,000 bipolar transistors with 0.2-μm-wide bases, which are very sensitive to defects. In the MOS transistors, the smallest feature size is the 2-μm gate length, which is easier to manufacture.

Not to be left behind in the supercomputer high-speed circuit race, bipolar gate arrays are being made in much higher densities. This keeps them in contention as a means of realizing smaller, faster, and cheaper supercomputers. The big challenge with bipolar chips is keeping them cool as the density increases.

FAST BIPOLAR GATE ARRAYS

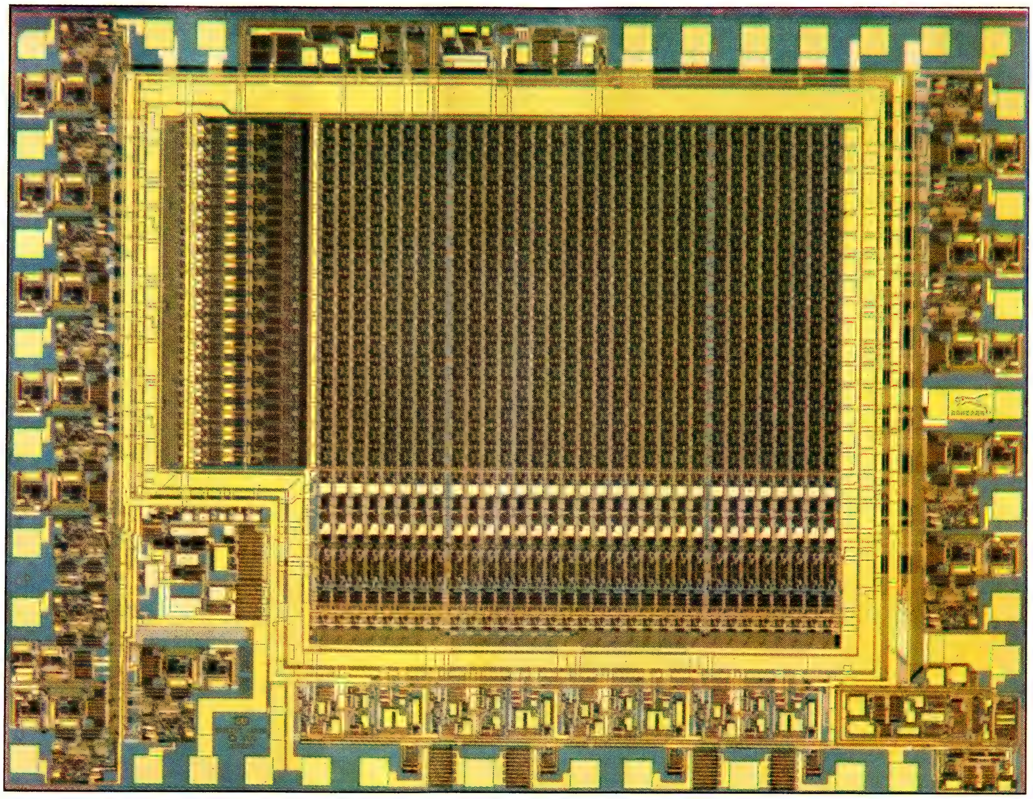
An example of the work under way in bipolar arrays is a 9,300-gate chip in development at the Components Group of Siemens AG, in Munich (Fig. 2). Featuring an internal gate delay of 150 ps, the chip is implemented in Siemens's third-generation ECL technology. Volume production will begin in 1987. Intended for use in the CPUs of high-speed computers and in control electronics, the chip has 320 pins.

Already on the market from Fairchild is a broad family of 225-ps ECL arrays ranging from glue-logic 50-gate chips to 2,500-gate models. Within 18 months, the company will be offering its next generation of ECL arrays, which will work under 100 ps. Fairchild has already shipped parts that have been clocked around a gigahertz—a couple at 1.1 and 1.3 GHz and several just under 1 GHz. Not only is Fairchild pushing silicon to some of the highest speeds yet attained, but it will soon also offer denser ECL arrays—upward of 10,000 gates—Fairchild's Ross says.

Two other companies prominent in fast bipolar gate arrays with large-scale fast chips are Nippon Telegraph & Telephone Corp. and Hitachi, both in Tokyo. NTT has announced an 80-ps 2,500-gate array compatible with ECL I/O signal levels. One of Hitachi's newest circuits is a 5,000-gate 250-ps ECL array on a silicon carbide substrate to dissipate heat faster.

Gallium arsenide has several advantages over silicon as a semiconductor material. At the top of the list is its switching speed, which is five times faster than silicon. GaAs can handle much higher frequencies—well above 5 GHz—whereas silicon begins to poop out above 1 GHz. It generates less internal noise and is also more resistant to radiation than silicon. Another advantage for many applications is that it operates over a wider temperature range.

Though many experts see GaAs as the technology of choice for the next generation of supercomputers, minisupercomputers, and, possibly, supermincomputers, they do not see it taking over all the functions in these machines. There will always be functions that can be performed by silicon-based VLSI circuits with adequate performance at much lower cost.



3. NANORAM. Gigabit Logic's 1-K GaAs static random-access memory has 1-ns access and cycle times. The memory chip is fully pipelined to be able to capitalize on its high speed.

Though the level of integration of available GaAs devices is still well below that of silicon parts, much progress toward increasing density is being made. Among the notable results is a 2,000-gate GaAs gate array made by Toshiba with direct-coupled FET logic. The array, unveiled at ISSCC, sports a gate delay of 42 ps unloaded and 215 ps loaded. An 8-by-8-bit multiplier fabricated with this chip achieved a multiply time of 8.5 ns—faster than a custom ECL 8-by-8-bit multiplier. The GaAs multiplier also consumes about 35% less power than the ECL version.

Another high-speed array, also presented at the ISSCC, is a 390-ps 1,000-gate GaAs chip using superbuffer FET logic from Oki Electric Industry Co., Tokyo. A superbuffer FET in GaAs is similar to an inverted superbuffer circuit in n-MOS, which consists of a first-stage enhancement/depletion gate and a second push-pull stage.

Though none of the Japanese GaAs gate arrays is on the market, U. S. observers expect the vertically organized Japanese computer-cum-IC companies to soon start using their GaAs arrays in their own machines. Three U. S. companies—Ford Microelectronics, Gigabit Logic, and Triquint Semiconductor—have commercial-product GaAs lines up and running.

SPEEDY STATIC RAM

Ford Microelectronics Inc. has just brought its GaAs production facility on line. The Colorado Springs subsidiary of Ford Motor Co. plans to produce several LSI GaAs digital logic circuits. The first two products will be a gate array with the equivalent of 1,000 conventional gates and a static RAM. The gate array, to be available by the end of the year, will run at twice the speed of ECL arrays while using half the power, says Dick Bryant, vice president of engineering development. The array will have ECL-compatible I/O signal levels. The second product will be a 1-K SRAM organized as 256 by 4 bits and running faster than 3 ns. The SRAM will have a pipeline architecture to take advantage of its blinding speed.

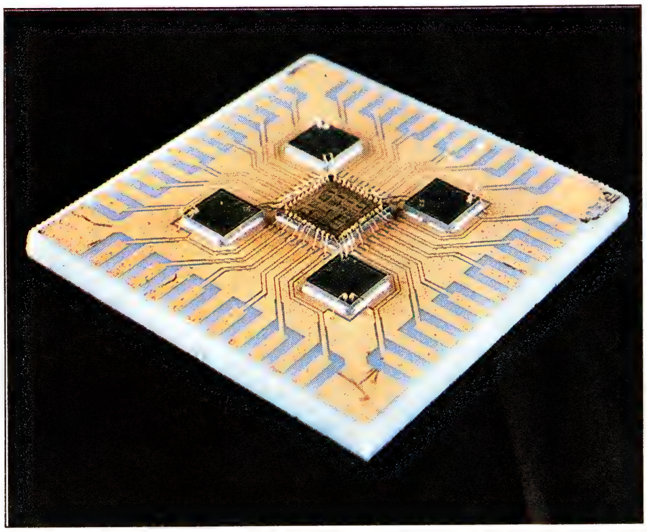
Ford is not alone in speeding up GaAs memory chips. Gigabit Logic Inc., Newbury Park, Calif., is readying a 1-K 1-ns RAM (Fig. 3) that will catch the eye of supercomputer designers on the prowl for ever-faster memory chips. This RAM will, like the Ford RAM, have a pipeline architecture configured so that the write cycle is as fast as the read cycle: both take 1 ns. Though Gigabit Logic has no GaAs gate-array products yet, it does have an extensive family of fast ECL-compatible small- and medium-scale products called Picologic. This line will soon include a number of Picologic circuits that support high-performance cache-memory designs for supercomputers, says Anthony Livingston, vice president of marketing. These chips are being readied to coincide with the introduction of the 1-K RAM.

The company has begun offering samples of 8 to 1 multiplexer and demultiplexer Picologic chips. These will be useful for serializing and communicating data across backplanes and to peripherals. The chips, which go into production in the fourth quarter, will initially have a 1.5-GHz clock rate, to be increased to over 2 GHz soon.

LOWER POWER DISSIPATION

Triquint Semiconductor Inc., Beaverton, Ore., a Tektronix Inc. subsidiary, has several GaAs LSI parts under development. The 1,000- to 2,000-gate arrays with maximum clock speeds of 1.2 to 2.0 GHz will be available in two to three years, says marketing manager Tom Reeder. Though the depletion-mode process being used to produce GaAs parts now could remain the fastest, its relatively high power dissipation could limit the packing density, just as in ECL. Reeder predicts that a new LSI GaAs process resulting in lower power dissipation and, therefore, higher densities, will be perfected for commercial IC production in two to three years.

Triquint is making and marketing an MSI GaAs cell array called a Q-Chip (Fig. 4). This chip contains the equivalent of 140 two-input NOR gates in a configurable array of cells and having a typical speed of 1 GHz and an upper limit of 2 GHz. The Q-Chip has many uses in high-performance computers because it was designed to build circuits now built in ECL



4. CELL ARRAY. Triquint's GaAs Q-Chip 28-cell array for high-speed digital systems also comes with 24 high-speed I/O drivers. Each core cell has 20 transistors and eight diodes. A D-latch can be formed in one core-cell; a master-slave flip-flop circuit can be built in two.

with lots of small-scale-integration parts. Triquint says the chip is designed for building very high-speed interfaces, not for building a whole computer.

Back on the memory front, in Japan Fujitsu has just announced the development of a GaAs 4-K memory chip that consumes 600 mW [*Electronics*, Sept. 2, 1985, p. 11]. It has an optimum address access time of 1.7 ns. Fujitsu plans eventually to use it in supercomputers.

Last year, the fastest 4-K GaAs memory was introduced by NTT. The chip has a reported access speed of 2 ns and uses 900 mW of power. Fujitsu also announced a 2.7-ns 700-mW memory last year.

Though impressive achievements are unfolding in CMOS, bipolar, and GaAs technologies, and more are sure to come, much faster circuits are being sought through the use of more unusual technologies. These are for use in the far future—after 1990. Research into the exotic worlds of materials in which electrons have high mobility and supercooled junctions is under way in many countries.

The first foray of Groupe Bull, France's principal computer manufacturer, into supercooled MOS was spurred by funding from the country's Direction Générale des Télécommunications. The agency wanted to compare what it considered some of the more promising high-speed technologies for future applications, and asked three French research laboratories to produce the same circuit. One used GaAs, another 1-μm and submicron MOS, and the third a supercooled n-MOS. They all decided to make a 3-bit adder, according to Antoine Boudou, who coordinated the project for Bull.

Because Bull's research laboratory at Les Clayes-sous-Bois had difficulty realizing depletion-mode transistors at submicron dimensions, it used an argon implantation method for very small square resistors, about 2 or 3 μm on a side, which it had developed for making polysilicon logic gates. When the Bull researchers supercooled the adder to a liquid-nitrogen temperature of 77 K, it reached a frequency of 400 MHz for a power consumption of 30 mW. Bull is encouraged enough by the results to extend the research with its own funds to supercooled CMOS.

The submicron n-MOS adder developed at the Laboratoire d'Electronique et de Technologie de l'Informatique in Grenoble scored 300 MHz for a 35-mW power consumption at room temperature. A GaAs adder produced at the principal Philips research lab in France, the Laboratoires d'Electronique et de Physique Appliquée, operates at 650 MHz for a power consumption identical to that of the LETI's submicron MOS.

In West Germany, Siemens researcher Doris Schmitt-Landsiedel has implemented n-MOS multiplier test chips that multiply 8 by 8 bits at a clock frequency of 330 MHz. When cooled to 77 K, the chip clocks at 600 MHz. The speed was achieved by using a special architecture based on a carry-save structure and a 1-μm technology.

At the Ruhr University in Bochum, a team under Berthold Bosch has developed regenerator (or decision) circuits for repeaters in optical communications. They boost the maximum transmission rate of 1.5 Gb/s achieved so far to better than 2.4 Gb/s. Intended for repeaters in optical communication systems, the circuits use a design concept based on parallel processing, as well as a relatively simple, yet fast, bipolar technology with pn isolation and 2.5-μm emitter-stripe widths. Computer simulations, Bosch says, have shown that a better technology—oxide wall isolation, for example—will lead to regenerator circuits with bit rates around 4 Gb/s.

EXOTIC TECHNOLOGIES

Investigating high-speed devices at the Philips Research Laboratories in Redhill, England, scientists have achieved significant results with molecular-beam epitaxy. With HEMT structures containing GaAs and AlGaAs, they have produced quantum-well lasers operating at wavelengths as short as 707 nm. They also have achieved high electron mobilities of more than 1 million cm^2/V per second in an extremely thin electron gas. This mobility could lead to transistors capable of high-frequency operation approaching 100 GHz, Philips says.

The structure is based on an AlGaAs layer grown on top of high-purity GaAs. At the interface between these materials, a two-dimensional cloud of electrons is formed in the GaAs. This electron gas can have an electron mobility far exceeding that of conventional doped GaAs: up to 1.5 million cm^2/V per second at low temperatures. This could lead to transistors that operate near 100 GHz. The requirements for such mobilites are high purity of the GaAs, good-quality interfaces, and accurate control of layer thickness down to the atomic level.

Researchers at Honeywell's Physical Sciences Center report a major advance toward GaAs VLSI with a technology analogous to CMOS in silicon [*Electronics*, July 1, 1985, p. 16]. Adding the low-power advantages of complementary structures in GaAs has been difficult because the positively charged holes have roughly one twentieth the mobility of speedy electrons, which travel five or six times faster through GaAs than they do through silicon. Honeywell claims to have solved this problem in a device called a heterostructure insulated-gate FET (HIGFET). The device could reach the commercial market in computers and other applications in the next three to five years, according to Honeywell.

Another recent achievement of note also comes out of the Physical Sciences Center. Researchers there claim to have produced the fastest-switching semiconductor transistor to date. It was demonstrated in GaAs modulation-doped FETs, which is Honeywell's version of an HEMT, in a 25-stage ring oscillator [*ElectronicsWeek*, May 13, 1985, p. 19]. The current traveled between two transistors in the ring of 25 in a record 11.6 ps at room temperature and in 8.5 ps at 77 K. Honeywell expects to use semiconductors developed from this research in manufacturing products in two or three years.

Fujitsu does not yet have any GaAs circuit products on the market, and it won't for a year to a year and a half, says Masaaki Kobayashi, deputy general manager of the Semiconductor Division of Fujitsu Laboratories Ltd., Atsugi. The company's most advanced device seems to be a metal-semiconductor FET it introduced originally in 1979, improved, and now uses in-house in simple logic-device and telecommunications light-transmission tests. The exciting thing about the device is that it is two to three times faster than bipolar devices while requiring two to three times less power, he says. Details are not available on Fujitsu's MESFET technology, but Kobayashi says it will soon be possible to mass produce a simple logic chip using the technology, which is the most mature of the GaAs transistor structures. As for more precise timing, Kobayashi predicts it will be a year or more before Fujitsu offers a GaAs or HEMT device.

But Fujitsu's first GaAs product probably won't be a memory chip, he believes. GaAs is considerably faster than silicon as a material, Kobayashi concedes. But as the scale of integration increases, less and less of the electron flow goes through the substrate and more goes through the wiring or channels, he says. "As an element, GaAs is fast, but in the interconnection, it is about the same as silicon." There is little value in going above 16-K in a memory device with GaAs, he adds. "Above that, it is a toss-up as to which will be faster." Though the GaAs might be two to three times faster, that might not be enough of an advantage to make up for GaAs's higher cost.

In supercomputers, "we won't be using GaAs for large memory chips," he says. "Rather, we'll use it for speed." So it looks like Fujitsu will stick with CMOS at least for about the next five years. It is in the discrete devices and logic chips that GaAs can really shine, he says. "I don't believe the post-silicon era will ever come about," says Kobayashi, who estimates that GaAs will never grab more than 2% of the semiconductor market.

SUPERCOOLING DEVICES

Kobayashi also sees a real future in cryogenics. He figures that supercooling HEMTs quintuples their actual performance (though their theoretical performance improves 10 times) and frozen CMOS performance doubles. "We are now at the entryway in the development of cryogenics. Cooling a whole computer would be too much, but cooling a small area is quite possible."

The most likely place for HEMT technology, he figures, will be in analog and digital amplifiers and frequency dividers for telecommunications and satellite communications. Not only does HEMT technology provide four times the speed of silicon, it creates less noise (static) than its silicon brother. Fujitsu, which has 20 people doing research on HEMT, has developed a memory prototype. Kobayashi did not say, however, when something might be on the market.

The consensus in Japan is that the semiconductor industry is undergoing a massive shift from n-MOS to CMOS. "n-MOS has no future," Kobayashi maintains.

The goals of the supercomputer project sponsored by the Japanese Ministry of Trade and Industry call for development of a 64-K GaAs memory chip and a 3,000-gate GaAs logic chip. GaAs and HEMT technologies developed through this project probably will not be used in Japanese supercomputers until 1988. It could take a year or two after that for Japanese participants in the program to get GaAs in their own machines.

Research in Josephson junctions could be even further away from commercial reality than GaAs [*Electronics Week*, Feb. 25, 1985, p. 28]. NEC Corp.'s Microelectronic Research Laboratories in Kawasaki recently demonstrated a 280-ps Josephson 4-by-4-bit parallel multiplier. The experimental multiplier circuit was fabricated using a 5-μm lead-alloy Josephson IC process. The speed and power dissipation (about 1 mW) are about one order of magnitude and two orders of magnitude smaller, respectively, than those achieved with high-speed semiconductor devices such as GaAs FETs.

Fujitsu and Toshiba are jointly leading the Josephson junction research in Japan's national supercomputer project. "The Josephson junction is still very unstable," says Akihiro Shibatomi, deputy manager of the compound semiconductor devices lab at Fujitsu Laboratories.

Not only do Josephson junction diodes have a difficult time controlling current within a circuit, but they are also very vulnerable to the stress of the unavoidable cooling-thawing-cooling cycle. "Josephson junctions are not next-generation technology," Shibatomi says. "They are three generations away." □

Additional reporting was supplied by Charles L. Cohen, Robert T. Gallagher, John Gosch, and Jonathan Joseph.

THE SEESAW RACE TO BUILD THE FASTEST CHIP

Circuits with propagation delays less than 1 ns were first achieved with bipolar technology in 1967. Two inventions before 1967 led to these speeds: the double-diffused bipolar transistor in the late 1950s and bipolar emitter-coupled logic in the early 1960s. When MOS technology arrived, it soon put bipolar at a disadvantage. In comparison with MOS, bipolar's complex fabrication, high power dissipation, and large device sizes turned out to limit the extent to which circuit dimensions could be scaled down.

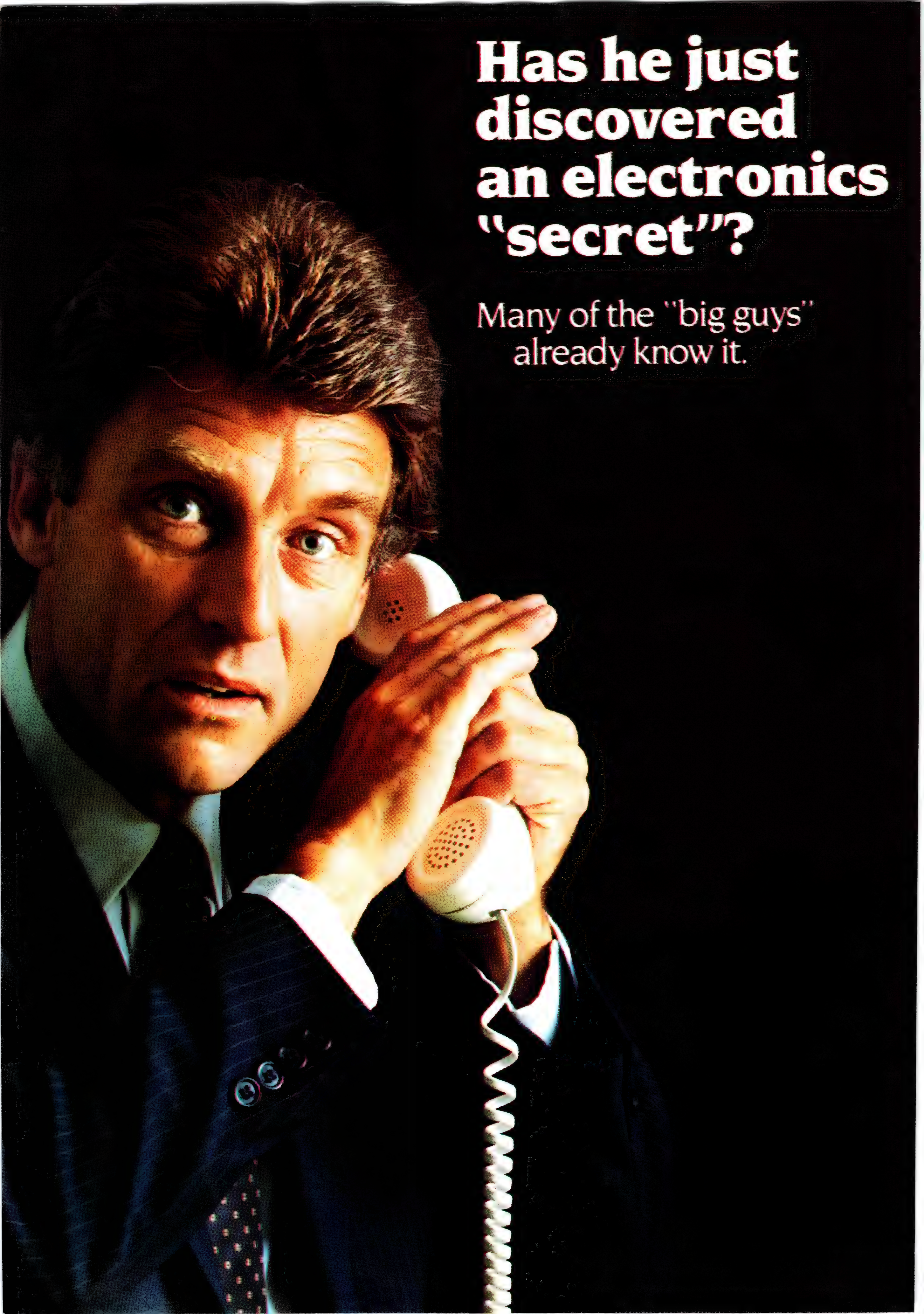
Thus bipolar fell behind MOS in the race to squeeze ever more functions onto a chip, although its shorter propagation delays kept it alive. Saturating bipolar-logic types—such as TTL (mid-1960s), integrated injection logic (early 1970s), and integrated Schottky logic (late 1970s)—have made impressive gains in lowering power dissipation and increasing density through smaller device sizes. But they have been unable to reach the fastest speeds of the nonsaturating ECL, which has been the process of choice for many designers of supercomputer chips. ECL is now being used in some mainframe and supermincomputers as well.

MOS technologies have progressed further down the trail of very large-scale integration. The 12-μm line widths in the MOS of the late 1960s have been reduced to today's 1- to 2-μm widths. Submicron widths are being achieved in laboratories, and a few products with these dimensions will soon reach the market. In the last 15 years, then, MOS propagation delays have decreased about a hundredfold, whereas bipolar propagation delays have decreased only about tenfold in the same period.

As reported at last winter's International Solid-State Circuits Conference, propagation delays of 30 ps have been measured and reported on experimental submicron MOS ring oscillators. And Waferscale Integration Inc., Fremont, Calif., has just introduced a CMOS 32-bit microprocessor slice that performs at bipolar speeds.

Speed improvements in MOS such as that of the Waferscale microprocessor slice could lead to a conclusion that bipolar as a very large-scale-integration technology has little or no future. Yet Advanced Micro Devices Inc.'s introduction of its Am29300 32-bit bit-slice family of bipolar chips indicated that bipolar VLSI is not yet ready to roll over and die. AMD just announced the availability of the first member of this family, the Am29325 floating-point accelerator [*Electronics*, Aug. 19, 1985, p. 48], in which the internal ECL gates have typical gate delays of 800 ps. A future member of this family will be the first 32-bit bipolar arithmetic-logic-unit chip.

For machines below the supercomputer class, CMOS VLSI will be the dominant IC technology by the decade's end. But for supercomputers, the competition is still fierce.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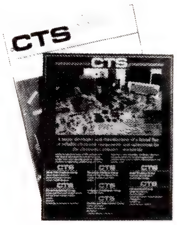

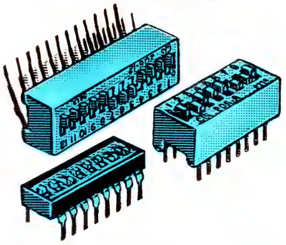

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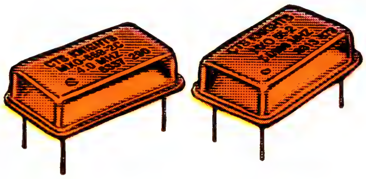

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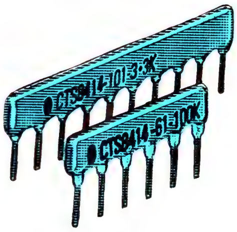

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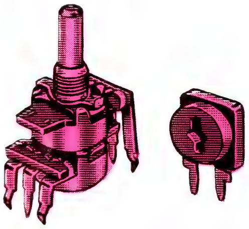

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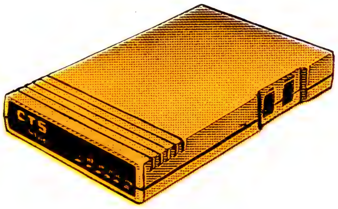

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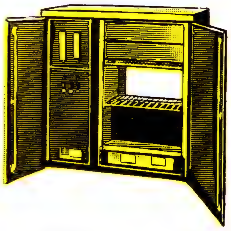

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# Electronics
October 14 issue

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Technology Update: Components

Military/Space Electronics Design
Demographic issue

Major chip categories (memories, microprocessors, and peripherals) are changing as the industry strives to improve performance and reliability. This report will cover extended capabilities of the custom and semicustom segment, 32-bit families, and the latest in analog chip development.

The Market
Active and passive components should amount to $27.5 billion in sales in 1985, and $31.1 billion next year.

Target Readers
Design engineers, technical managers, and technically trained executives.

Issue Date: October 14, 1985

Closing for Advertising: September 23, 1985

Electronics
Influence Beyond Design

# Electronics
October 21 issue

For Space
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Technology Update: Communications

Special Advertising Section: France

Rapidly changing technology in fiber optic and satellite transmission systems, local area and value-added networks, PBX and central office switches means a full range of new equipment to keep up with. This article tracks and analyzes the latest in these areas and projects the next wave of technology.

The Market
$33.8 billion in the U.S. this year; $38.5 billion by 1986.

Target Readers
Communications carriers; data transmission equipment manufacturers; local area network manufacturers; computer, terminal, and printer manufacturers.

Issue Date:
October 21, 1985

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September 30, 1985

Electronics
Influence Beyond Design

PRODUCTS NEWSLETTER

STARTUPS LEAD THE WAY IN INTRODUCING CMOS EEPROMS

The bandwagon for EEPROMS made in CMOS is beginning to pick up speed. Surprisingly, however, the first products to be introduced have not come from market leaders such as Intel and Seeq but instead from U. S. startups. International CMOS Technology Inc., a two-year-old company in West Lafayette, Ind., is delivering samples of its first product—a 1-K EEPROM. It follows closely on the heels of Sierra Semiconductor Corp., Sunnyvale, Calif., which has just started selling two CMOS EEPROMs [*Electronics,* Aug. 26, 1985, p. 53]. International CMOS will start selling its 93C46P device in production quantities late this month. Price will be $4.25 each in quantities of 1,000. Fabricated in a 3-micron CMOS floating-gate technology, the serial-access 5-V chip is organized as 64 16-bit registers. Seeq, San Jose, Calif., has delivered samples of 64-K parts to the military but will not announce general availability before October. ☐

ADAGE OFFERS BOTH IBM AND DEC ENVIRONMENTS IN A CAD WORK STATION

Engineers shopping for computer-aided-design work stations can now have the best of two worlds. This week, Adage Inc. is introducing a family of work stations that can emulate environments from both IBM Corp. and Digital Equipment Corp. Three of the four new work stations from the Billerica, Mass., company are based on DEC's Microvax II. They will allow users to toggle from an DEC VT 240 terminal mode to an IBM Cadam CAD system. ☐

SUNRISE BOOSTS PROGRAMMER'S RATE WITH EXCHANGEABLE BOARDS

A new way to increase the output of gang EPROM programmers is coming from Sunrise Electronics Inc. The Glendora, Calif., company is introducing the Z-3000 gang programmer with an exchangeable board architecture that enables an operator to reload all the sockets of one board while EPROMS on a second board are being programmed. This makes it possible to program up to four times as many chips per hour as other gang-programming units, the company claims. Exchanging boards takes less than five seconds. Also boosting the programmer's speed is a high-speed verification algorithm that Sunrise claims is the fastest in the industry. The programmer, to be unveiled at Midcon in Chicago this week, will sell for $3,500. ☐

EXAR'S ICs WILL BUILD A LINE-RECEIVER TO HANDLE MULTIPLE RATES

A pair of new bipolar chips can provide all the active circuitry needed to build line receivers using either pulse-code modulation or alternate-mark inversion. Either IC can handle links up to 6,300 ft. The highly versatile ICs from Exar Corp. fit applications that operate at T1 rates of 1.544 Mb/s, T1C rates of 3.152 Mb/s, and at the European rate of 2 Mb/s. Both the XR-T5640 and T5740 operate from a single 5.1-V power supply and feature three matched ports for performing automatic line build-out. In lots in 1,000, the T5640 sells for $5.83 and the T5740 for $5.91 each. ☐

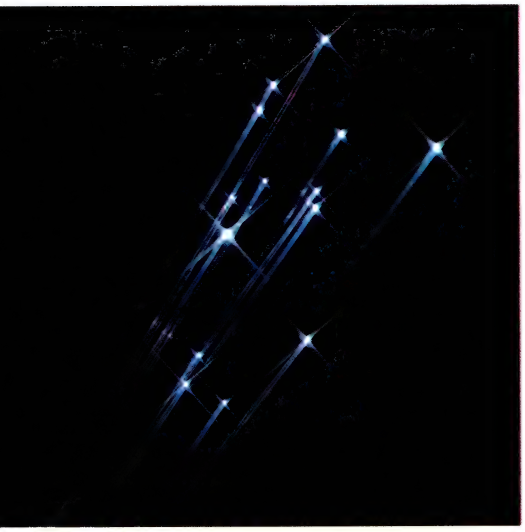
RAM-BASED DRIVE CONNECTS TO EIGHT HOST COMPUTERS

Storage Technology Corp., Louisville, Colo., is increasing the memory capacity of its 4035 Optimizer RAM-based disk-drive substitute and doubling the number of computer channels it can serve. The enhanced 4305E uses 256-K RAM chips instead of 64-K parts, increasing storage to 768 megabytes from 192 megabytes. With an optional four-channel switch, it can link to eight different channels or eight different host computers. The 4305E with one controller and 12 megabytes sells for $69,100 and is available now. ☐

A Few Question
Fiber Optic

Why all the excitement about fiber optics?

Because this new technology has a number of advantages over wire and microwave communications.



For one thing, these tiny optical fibers are substantially smaller and lighter than wire cables; for another, they're almost immune to electromagnetic interference. They're particularly effective for the high-capacity digital signals that are making up more and more of today's telephone traffic.

What about testing those fiber optics circuits?

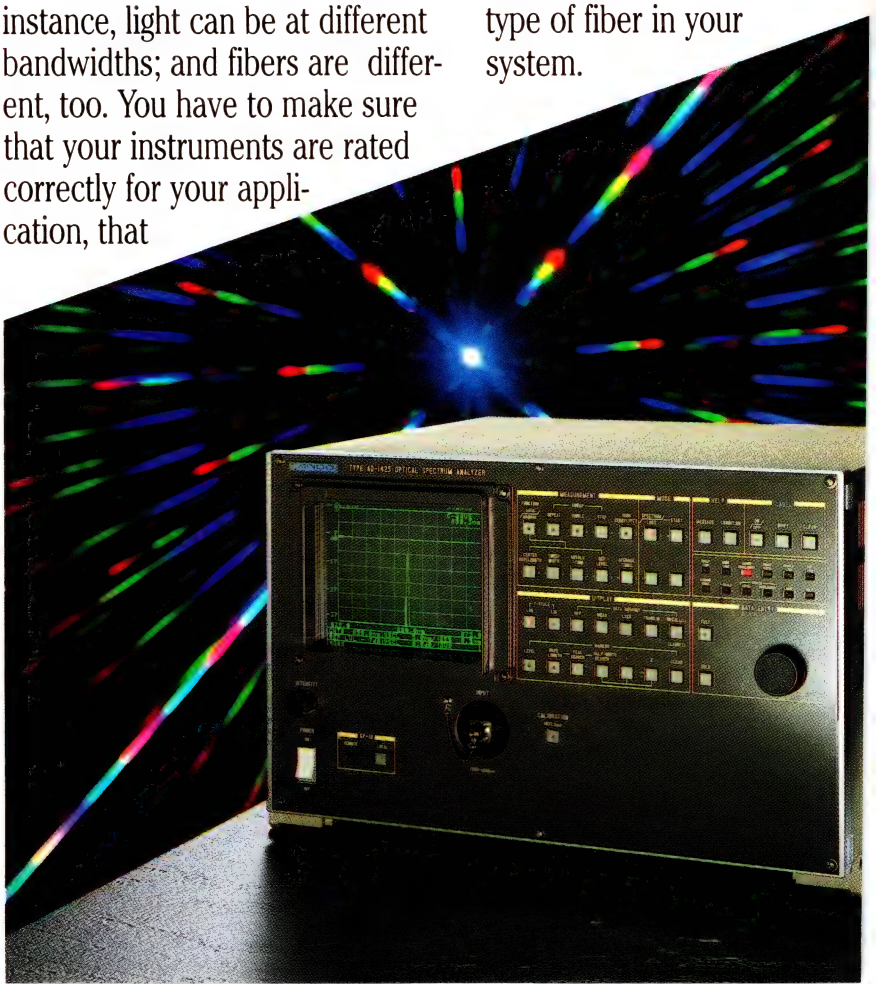
As you might expect, you need highly specialized test gear for this unique communications medium.

I heard fiber optics test equipment is heavy and expensive. Is it?

It doesn't have to be. For instance, Ando Electric, a major player in the fiber optics game, offers a digital-reading optical power meter that fits right in your pocket.

Is compatibility a problem?

There are actually many different kinds of fibers and light used. For instance, light can be at different bandwidths; and fibers are different, too. You have to make sure that your instruments are rated correctly for your application, that you have the right adapters f the optical bandwidth and the type of fiber in your system.



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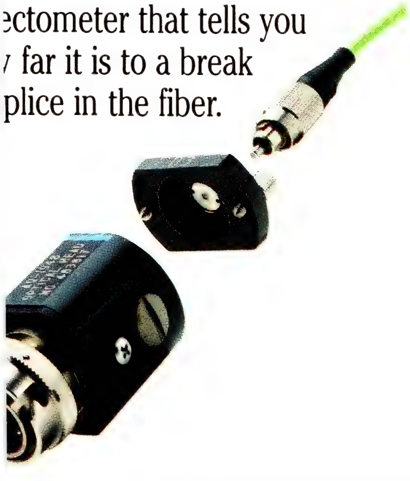
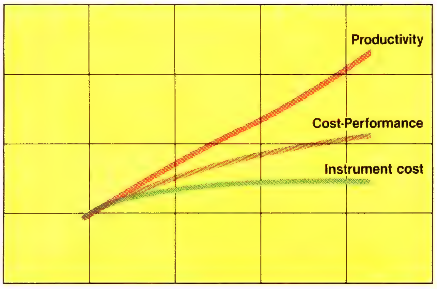


What else does Ando have to offer?

Glad you asked. Ando has been making communications test equipment for more than a half-century. So we know how to build accurate instruments that stand up to the rigors of the bench and the toolbox. It's part of our total cost-performance concept.

What do you mean by "total cost-performance?"

Looking at **overall** results rather than just cost. Ease of setup, learning curve, accuracy, reliability, GPIB compatibility: they're all part of the equation. Put simply, cost-performance means that the bottom line isn't always visible on the price list.



If you have more questions about fiber optics testing, an Ando representative will be happy to help you.

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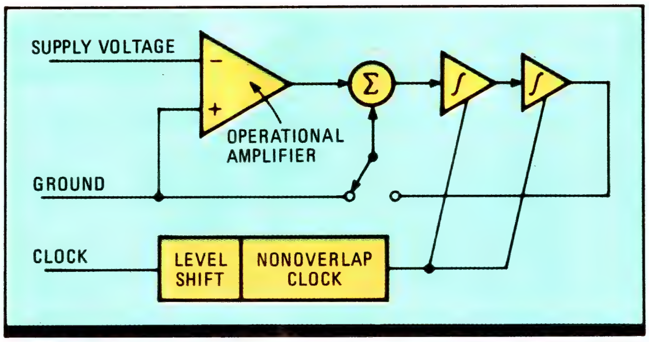
Circle 103 on reader service card

UNIVERSAL CMOS BLOCKS BUILD HIGH-PERFORMANCE FILTERS

LINEAR TECHNOLOGY'S FILTER CHIPS WORK FROM A 5-V SUPPLY

Thanks to a building-block approach, a family of universal monolithic filters from Linear Technology could simplify the construction of any type of filter. Built in the company's 2-μm silicon-gate linear CMOS process, the filters have lower offsets, higher dynamic range, and wider center frequencies and center frequency-Q products than competing devices built in a metal-gate process.

The filters, designated the LTC1059, -1060, and -1061, consist of one, two, and three high-performance switched-capacitor filters, respectively, on a single chip. They have an 85- to 90-dB dynamic range at 10 V, versus 70 to 80 dB for competing devices such as National Semiconductor Corp.'s MFIO and comparable parts, says Robert Dobkin, vice president of engineering. They consume 5 mW/filter block at 10 V, versus 40 to 80 mW/block for other filters.



BUILDING BLOCK. Virtually any of the classical filter types can be assembled by using Linear Technology's basic filter circuit.

The filters require a ±2.35 to ±9-V supply range versus 8 to 13 V for current monolithic filters, making them the first such devices than can operate from a single 5-V supply. The filters operate over a temperature range from –55°C to +125°C, compared with a typical range of 0° to 70°C for other devices. The filters boast a center frequency of 30 kHz with a Q of 5 (versus 20 kHz) and a center frequency-Q product of 600 at 20 kHz (compared with 100).

Each filter block, together with two to five resistors, produce various second-order filter functions such as low-pass, bandpass, high-pass notch, and all-pass. Users can tune the center frequency of these functions by an external clock and resistor ratio. Designers can achieve up to fourth-order full biquadratic functions by cascading the two filter blocks in the 1060 and up to sixth-order six-pole functions by cascading the three filter blocks in the 1061. This approach implements any of the classical filter functions, such as Butterworth, Chebyshev, Bessel, and Cauer.

The 1060, for example, can operate with either a single or dual supply from ±2.35 V to ±9 V. When used with a single 5-V supply, the two-filter-block unit typically consumes 12 mW and can operate on center frequencies of up to 10 kHz. With a ±5 V supply, the frequency range extends to 30 kHz. The use of a ±2.5-V supply yields a dynamic range of 88 dB. Crosstalk is no more than 70 dB. Over the full temperature range, the center frequency varies no more than ±0.3% on the 1060 to +0.8% on the 1060A. Comparable center-frequency specifications for competing devices range from 0.6% to 1.5%, says Dobkin, but only at 25°C. Q accuracy is ±0.5% typical for both types.

By adding the appropriate resistors, capacitors, and other external components, the 1060 can be configured to operate in three main modes, says Dobkin. In the first mode, the 1060 acts as a clock-tunable notch and is a practical configuration for second-order clock-tunable bandpass/notch filters. This mode produces a bandpass with a very high Q output but does not create problems with the dynamics of the remaining notch and low-pass outputs.

In a second mode, the 1060 makes use of a separate notch-output frequency, which can be tuned independently of the center frequency. This mode is useful, says Dobkin, when the user needs cascading second-order functions to create an overall elliptic high-pass, bandpass, or notch response. The third mode allows the device to operate in a state-variable configuration to provide a high-pass, bandpass, or low-pass output through progressive integration.

Applications for the filters include audio and telecom systems, signal processing, and any application requiring medium-frequency or very high Q and high-dynamic-range bandpass notch filtering with a single 5-V supply. In lots of 100, the 1059, 1060, and 1061 sell for $3.25, $6.00, and $8.25 each, respectively. All are available now. *–Bernard Conrad Cole*

Linear Technology Corp. 1630 McCarthy Blvd., Milpitas, Calif. 95035. Phone (408) 942-0810 [Circle reader service number 338]

OPTICAL FIBER EXTENDS PARALLEL INTERFACE LINK

Manufacturers of fiber-optic data links are going to great lengths to show that lightwave technology outperforms copper wire [*Electronics*, Sept. 2, 1985, p. 30]. The latest to do so is Raycom Systems Inc., which has what it believes is the first optical-fiber replacement for standard parallel computer-to-printer interfaces.

The Raycom 2300/2302 termination boxes extend the maximum allowable distances of Centronics-compatible parallel interfaces from 10 ft to as much as 3,000 ft using fiber-optic transmission technology. The lightwave transmission system has been designed to allow printers to operate at up to 7,000 characters/s, or about 3,100 lines/min, over extended distances. Typically, the rate on the copper is about 2,000 lines/min, depending on the application.

"The standard Centronics parallel interface has a set limit of 10 ft between computer and printer, which many times is not even adequate for most computer rooms—not to mention remote applications where printers might be down the hall of a building," says Matt McConnell, project manager at Raycom.

RS-232-C serial interfaces, which are slower but have longer distance limits, typically have been used to extend the distance of high-speed parallel printer ports. But their copper-wire medium often suffers from electrical-noise interference and bit errors caused by signal attenuation as the lines get longer. Beginning at about 50 feet, the speed and bit-error limitations of copper wire become apparent in high-speed links to parallel printers, McConnell adds.

The 2300 (which attaches to the computer) and the 2302 (which links at the printer) actually transmit parallel-port data over a single fiber in serial fashion. The serial transmission is transparent to both ends of the link. Data is buffered at both ends as the unit converts transmissions to and from the serial format.

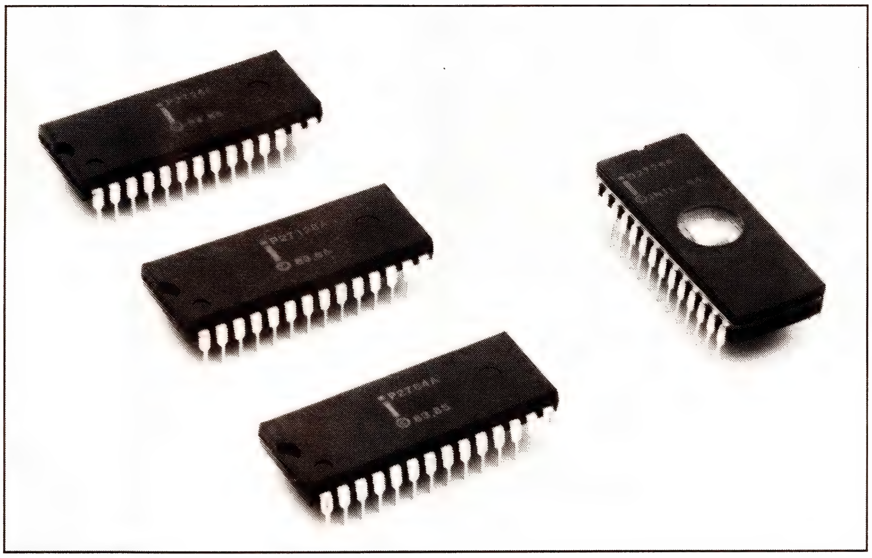
The 2300/2302 employs a half-duplex transmission scheme to communicate bidirectionally over a single 200-µm fiber. Characters fed into the 2300 by the computer parallel port are echoed back by the 2302 printer attachment.

The 2300 and 2302 contain standard 36-pin Centronics-compatible female parallel connectors. The nominal bit-error rate is 10^{-9}. The units operate from an external power supply of 120 V ac input, 1.8 W. Input power is +9 V at 100 mA. On the optical side of each of the boxes, the 2300 and 2302 feature a bidirectional fiber-cable port that operates with an 820-nm wavelength.

The fiber-optic links have a noise-line margin of 10 dB. The link boxes, which can operate in temperatures from 0°C to +55°C, measure 1 by 6.2 by 5 in. In single-quantity orders, the 2300 and 2302 pair of fiber-optic links sells for $650. *–J. Robert Lineback*

Raycom Systems Inc., 6395 Gunpark Dr., Boulder, Colo. 80301.
Phone (303) 530-1620 [Circle 340]

INTEL'S EPROMS HIT THE ASSEMBLY LINE



WINDOWLESS. Intel's EPROM can be programmed so fast it can be done on an assembly line.

Faster programming algorithms and durable plastic packaging suit the latest Intel one-time-programmable 256-K EPROM for automated assembly. Unlike ceramic housings, the P27256's windowless, plastic dual in-line package is chip- and crack-resistant. Plastic DIPs also cost less than ceramic ones.

Programming the EPROM takes as little as four seconds with Intel's new Quick-Pulse Programming algorithm. Previously, programming the 256-K EPROM with the Inteligent Programming Algorithm, which uses a 1-ms pulse width with an overprogram pulse three times as long, typically took three to six minutes, depending on the complexity of the program. Therefore programming is usually performed away from the assembly line.

The Quick-Pulse Programming Algorithm, however, uses a pulse width of just 0.1 ms and eliminates the precautionary overprogram pulse altogether. The voltages for both programming pulses and byte verifications have been raised by 0.25 V, to 12.75 V and 6.25 V, respectively. The increased voltages are required by the Quick-Pulse algorithm to ensure successful, accurate programming at the much lower pulse widths.

Intel is using the Quick-Pulse algorithm in-house and will make it available commercially later this year as an upgrade to the company's Universal programmers. In addition, Intel is working with Data I/O Inc. to provide the optimum time capability on the Redmond, Wash., firm's PROM programmers.

Even on existing equipment, the new algorithm is faster. The algorithm can program 20 P27256 EPROMs in 68 s using Data I/O's model 120 or 121 gang programmers. And with a Fast 27/K CON conversion package, priced at $150, Intel's Universal programmers can program the P27256 in 35 s, about one sixth the previous time. In addition, the new programming software allows IBM Corp. Personal Computers to host the programmers, which further facilitates programming the EPROMs on an assembly line.

Manufactured with Intel's 1.5-µm HMOS II-E process on 6-in. wafers at the company's Albuquerque, N. M., facility, the P27256 is functionally identical to the ceramic dual-in-line 27256. Though these windowless components can be programmed only once by the customer, an extra row of memory cells on the EPROMs gives users the choice of testing the chips for speed and temperature performance without losing any storage capacity. Intel tests the PROMs for programmability and data retention by writing on them once and then erasing them with ultraviolet light at the wafer stage before assembly into DIPs.

Thanks to Intel's proprietary multilayer oxynitride passivation, the plastic DIP's seal is just as hermetic as the ceramic's, guaranteed to withstand 85°C at 81% humidity for 1,000 hours. The new plastic EPROMs are also cheaper: in 10,000-piece lots, the 200-ns P27256 costs $13.60 each compared with $14.20 for the Cerdip 27256. Parts are available now in volumes sufficient for use in production. *–Eve Bennett*

Intel Corp., Memory Components Division, 151 Blue Ravine Rd., Folsom, Calif., 95630. Phone (916) 351-8080 [Circle 339]

CMOS LOGIC ARRAY HAS BIPOLAR SPEED

A low-power CMOS mask-programmable logic array with bipolar speeds makes a suitable replacement for the popular standard 7400- and 4000-series logic devices. Constructed in VLSI Technology Inc.'s proprietary 2-µm double-layer-metal silicon gate CMOS process, the VP16RP8M operates from –0.3 to +6.0 V and boasts a maximum propagation delay of 25 ns at 45 mA. Available in an industry-standard 300-mil 20-pin DIP, the array is compatible with the 300-mil, 20-pin AND and OR array structures incorporated in conventional bipolar PLAs and their hard-wired logic equivalents.

Customer logic equations are implemented through a metal-mask option to make customer-specified connections in the AND and OR planes, rather than using the fuses or EPROM cells found in field-programmable logic arrays.

To aid in testing, the VP16RP8M has special circuitry built in to allow them to be preloaded to any desired active-high or -low level, forcing defined states into the registers to minimize test time. Test time is reduced since it is no longer necessary to incrementally sequence the inputs to get the desired state.

Using a proprietary design-automation system, VTI can create custom masks and prototypes either directly from Boolean logic equations, existing programmed PLA master devices, or Jedec-formatted source code files.

When PLAs are used as the input, two devices must be compared to ensure code integrity. VTI reads the arrays, automatically enters the logic equations into the design-automation system, and then produces a fuse map, which is returned to the customer for verification.

In addition to replacing 7400 and 4000 series devices, the VTI array is configurable so that it can also substitute for a variety of standard PLAs.

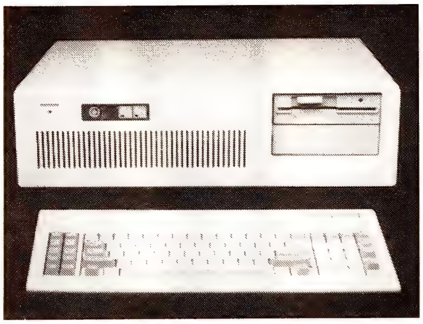
Preprogrammed samples of the array are available now. The parts, in lots of 5,000, sell for $1.90 to $2.50 each, depending on the logic array's complexity and speed. *–Bernard Conrad Cole*

VLSI Technology Inc. 1109 McKay Dr., San Jose, Calif. 95131.
Phone (408) 942-1810 [Circle 341]

IBM PC AT COMPATIBLE SELLS FOR $2,795

Priced at $2,795, the AT computer is compatible with the IBM Corp. Personal Computer AT and offers expandable RAM—up to 4 megabytes with add-on cards. For mass storage, the computer uses a 1.2-megabyte floppy-disk drive; 20- and 40-megabyte hard-disk drives are optional. Eight card slots leave room for system expansion. The AT, which is built around the 16-bit 80286 microprocessor, also features three programmable timers, seven-channel direct memory access, and 16-level interrupt.

For fast screen dumps, a Print Screen key is included on the keyboard, and a separate cursor and numeric keypad are options. The basic $2,795 AT includes 512-K bytes and one disk drive. A similar system that also includes a serial or parallel interface card and a 40-megabyte hard disk sells for $3,895.

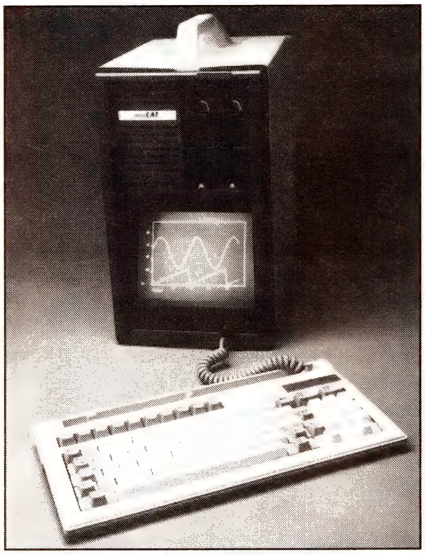


American Computer & Peripheral Inc., 2134 S. Ritchey, Santa Ana, Calif. 92705.
Phone (714) 545-2004 [Circle 350]

PORTABLE OFFERS 8087 COPROCESSOR

Datacat, a portable computer with a 1.3-ft^2 footprint, comes with an 8087 math coprocessor, making it an IBM Corp. Personal Computer/XT-compatible dedicated to scientific and technical applications, including computer-aided testing and automatic test systems. The Datacat offers 512-K bytes of memory, serial and printer ports, three add-on slots, graphics capability, and an IEEE-488 interface bus. Options include hard-disk drives, analog-to-digital converters, and printer-plotters.

The system is available now and sells for $2,495. A $1,650 version, for original-equipment manufacturers who wish to add their own custom circuits, comes with 256-K bytes of memory and two floppy-disk drives, but without the 8087 coprocessor and the IEEE-488 interface bus.



Datacraft Inc., 13714 S. Normandie Ave., Gardena, Calif. 90249.
Phone (800) 421-2289; in California, (213) 321-2320 [Circle 351]

LINE-INTERFACE IC CONSUMES JUST 46 mA

The T5680 pulse-code-modulation line-interface IC contains both transmit and receive circuitry. It receives at bit rates of up to 10 Mb/s and consumes only 46 mA, maximum. Transmit rate is 2 megabytes/s. In the receive mode, incoming bipolar pcm signals attenuated by the transmission medium are applied to a peak detector from which the data and clock threshold-detection voltages are produced. In the transmit mode, two TTL output drivers with open-collector output stages can each handle a maximum of 40 mA.

The T5680 line interface is priced at $5.21 each, in quantities of 1,000, and is available now.

Exar Corp., 750 Palomar Ave., P. O. Box 3575, Sunnyvale, Calif. 94088.
Phone (408) 732-7970 [Circle 357]

CHIP HOLDS ANALOG, DIGITAL ARRAYS

In the FB330 series, both linear and digital arrays can be located on the same bipolar chip, thanks to the design's mosaic approach: because component groups are functionally isolated, systems designers can integrate analog and digital circuitry on the same chip without creating signal noise. Applications for the FB330 series include data acquisition, instrumentation, telecommunications, and any other application that requires a combination of analog and digital functions.

The array has eight general-purpose analog tiles and one band-gap voltage-reference tile, plus 96 basic gates and 20 I/O cells. Digital cells are TTL-compatible, and 16 analog macrocells and 15 logic macrocells are now available to designers. The array operates over the commercial and military temperature ranges (−55°C to +125°C) with an average gate delay of 4 ns and per-gate power dissipation of 2 mW. The FB330 series is supported by CAD I and Spice circuit-simulation software.

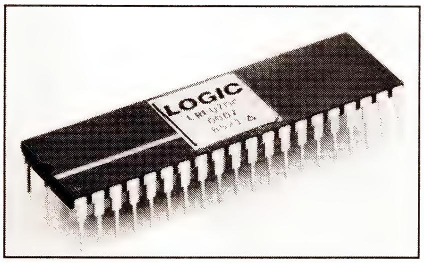
In 1,000-piece quantities, the FB330 is priced at about $9 each. Delivery of prototypes takes 8 to 14 weeks.

Micro Linear Corp., 2674 N. First St., San Jose, Calif. 95134.
Phone (408) 262-5200 [Circle 356]

REGISTER FILE HAS BIDIRECTIONAL PORT

An 8-word 8-bit CMOS register file with three ports, the LRF07 features one input port, one output port, and one bidirectional port. Each is independently controlled, and all three are simultaneously accessible on each clock cycle. The bidirectional port operates in one direction on a given clock cycle, allowing simultaneous input or output through two ports.

With a data-access time of 35 ns, the LRF07 can serve in a high-speed cache memory or in configurations that need the high bus bandwidth available with a multiport memory. It is also applicable in designs where two processors share data or a common resource such as a coprocessor. The LRF07 supports all popular register-transfer architectures, the manufacturer says.



Available in plastic or ceramic 40-pin DIPs, the LRF07 is priced at $19.50 and $32.50 each, respectively, in 100-unit lots.

Logic Devices Inc., 628 E. Evelyn Ave., Sunnyvale, Calif., 94086.
Phone (408) 720-8630 [Circle 358]

MINIATURE RELAY SQUELCHES POWER

Designed to save critical pc-board space, a relay that measures 15.8 mm long by 9.7 mm wide by 7.8 mm high boasts a maximum switching voltage of 125 V dc or ac. The FBR40 double-pole double-throw relay has a built-in permanent magnet that holds down operating-power consumption to 85 mW—rated power consumption is 150 mW—which gives it an edge for telecommunications circuits. Further, the relay can withstand surges of over 1,500 V.

Available in sample quantities in eight to 10 weeks, the ultraminiature FBR40 is priced starting at $1.68 each in quantities of 1,000 pieces.

Fujitsu Component of America Inc., 918 Sherwood Dr., Lake Bluff, Ill. 60044.
Phone (312) 295-2610 [Circle 372]

850-nm LED BOASTS 200-MHz BANDWIDTH

Cap Rock LEDs are Honeywell's replacements for its Sweet Spot line, and the 850-nm emitters can substitute for Sweet Spot units in existing circuits without changing connectors. Cap Rock LEDs have a rise time of 4 ns and a 3-dB analog bandwidth of 150 MHz—faster 200-MHz versions are also available.

Applications for Cap Rock LEDs in-

7.

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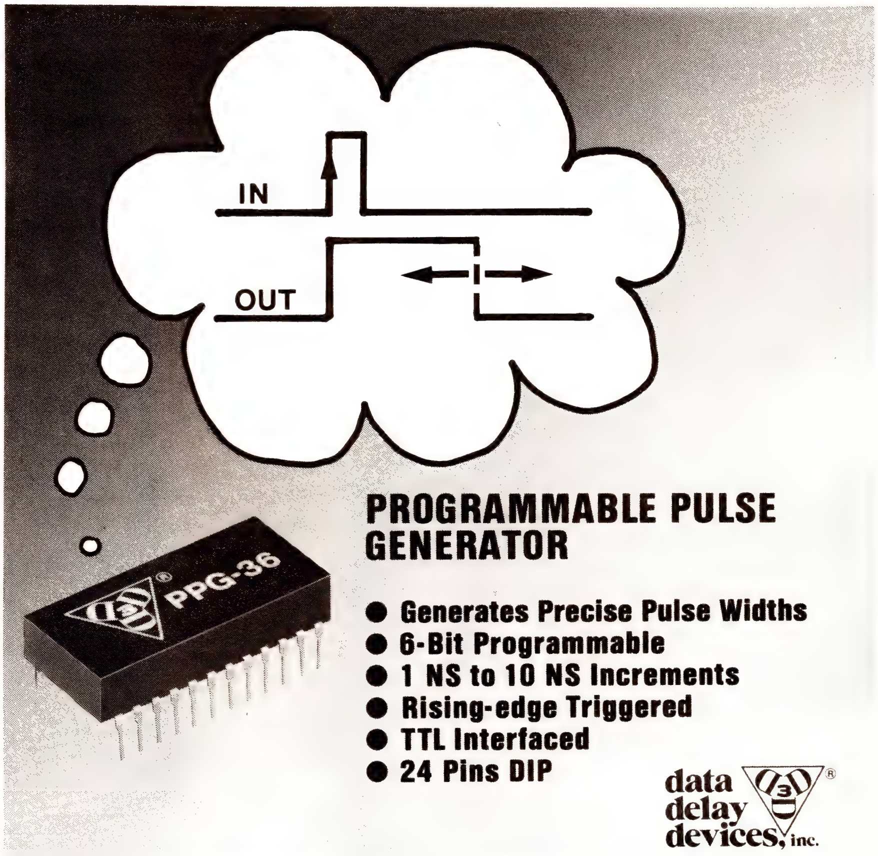
Circle 107 on reader service card



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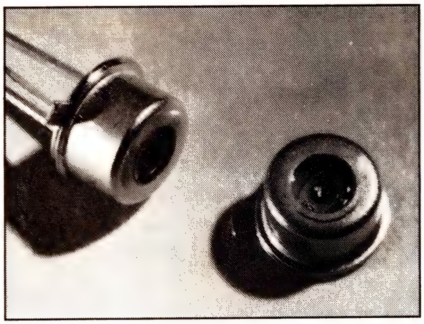
385 Lakeview Avenue, Clifton, New Jersey 07011 ■ (201) 772-1106

Circle 125 on reader service card



clude local networks, high-speed optical data links, and cable TV. In quantities of 1,000, the model HFE4000 in a hermetically sealed can sells for $13.75. The model HFE4001, the same chip in a plastic-capped package, sells for $5. Both are being shipped in production quantities now. The Cap Rock line is also sold ready-mounted and aligned in several popular connector models.

Honeywell Inc., Optoelectronics Division, 830 E. Arapaho Rd., Richardson, Texas 75081. Phone (214) 234-4271 [Circle 369]

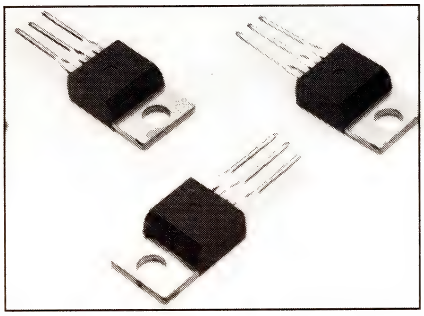
MOS FETs HAVE 50-V BREAKDOWN VOLTAGE

Two MOS FETs deliver high-current, very low on-state-resistance power switching for industrial applications and replacement of mechanical relays. The BUZ11 and BUZ11A are specified for a 50-V breakdown voltage, 30-A continuous drain current, and respective on-resistances of 0.04 Ω and 0.06 Ω. The manufacturer guarantees a forward transconductance of at least 4 siemens, and the turn-on time is 30 ns.

The MOS FETs are fabricated in Duramos, the company's high-density DMOS process, which packs over 850,000 cells per inch. For protection purposes, an internal diode with full current handling capability is included. This eliminates the need for a discrete component, the company says.

Samples are available from stock, and production quantities are shipped in eight weeks. Units prices for the BUZ11 and the BUZ11A are $3.83 and $3.31, respectively, in 1,000-piece quantities.

Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. 95054.
Phone (408) 988-8000 [Circle 370]



THYRISTOR DIVERTS POWER TRANSIENTS

A monolithic thyristor, the Surgector incorporates a gate region with a diffused section that acts as a zener diode. The device diverts dangerous transient energy away from the sensitive electronic circuitry of telephones or computers.

The Surgector initially clamps the surge voltage by zener action until the integral thyristor turns on and drops the voltage to a low value. In most cases, the manufacturer says, the protected circuitry never sees a voltage more than 130% of normal operating voltage.

The Surgector is offered in two- and three-terminal versions and in voltage ratings of 30, 58, and 225 V. Surgectors are designed with holding currents above 100 mA to assure that they will operate in normal telecommunication circuits. In quantities of 10,000, unit prices range from 58¢ to $1.06.

RCA Corp., Solid-State Division, Route 202, Somerville, N. J. 08876.
Phone (201) 685-6545

CONVERTERS GRAB 20 MILLION SAMPLES/S

For signal processing and data conversion, a pair of 8-bit flash analog-to-digital converters sample at the rate of 20 megasamples/s. With an input dynamic range of 2 V and outputs that are programmable to either binary or inverted binary, both feature externally adjustable conversion linearity.

The IR3K03 is output-ECL compatible and the IR3K04 is output-TTL compatible. Both are suitable for industrial controls, video, and instrumentation systems. Available in 28-pin DIPs, the converters sell for $135 each in quantities of 100. Delivery takes 12 weeks.

Sharp Electronics Corp., 10 Sharp Plaza, Paramus, N. J. 07652.
Phone (201) 599-3750 [Circle 367]

MONOLITHIC ADC IS ACCURATE TO 13 BITS

Accuracy to 13 bits and stability of 1 ppm/°C mark the MP7550 monolithic analog-to-digital converter. The converter achieves this through an integrating technique—quad slope—in which conversion consists of four slopes of integration instead of the usual two. Conversion time is about 40 ms with a 1-MHz clock, which can be externally controlled or internally generated.

The MP7550 is microprocessor-compatible and uses the 2's-complement method. For most applications, it needs only three resistors, one capacitor, and a reference voltage, because all other required components are on the CMOS chip. A wide range of power-supply voltage—±5 V to ±12 V—with low current requirements make the MP7550 suitable for low-power or battery-operated applications.

In 100-piece quantities, the MP7550 ADC sells for $12.95 in a 40-pin plastic package, for $25.50 in a 40-pin Cerdip. Delivery takes up to four weeks.

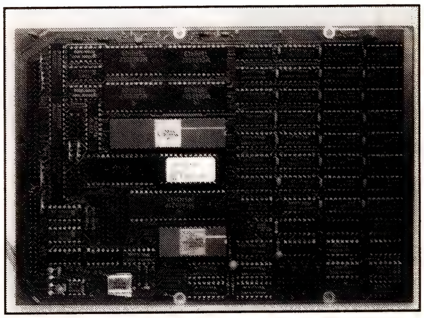
Micro Power Systems Inc., 3100 Alfred St., Santa Clara, Calif. 95054.
Phone (408) 727-5350 [Circle 366]

COMPUTER FITS IN A 5¼-IN. DISK DRIVE

The Uniquad single-board multiuser computer can mount directly on a 5¼-in. floppy-disk or hard-disk drive, creating a very compact computer system. Featuring a 68008 microprocessor running at 8-MHz, the Uniquad supports two 5¼-in. floppy-disk drives and includes a Shugart Associates Systems Interface for connecting a hard-disk controller.

The board comes with 128-K bytes of memory but can be expanded to 512-K bytes. Two parallel and four serial ports, with baud rates that are selectable from 300 bits/s to 19.2 Kb/s, handle I/O operations.

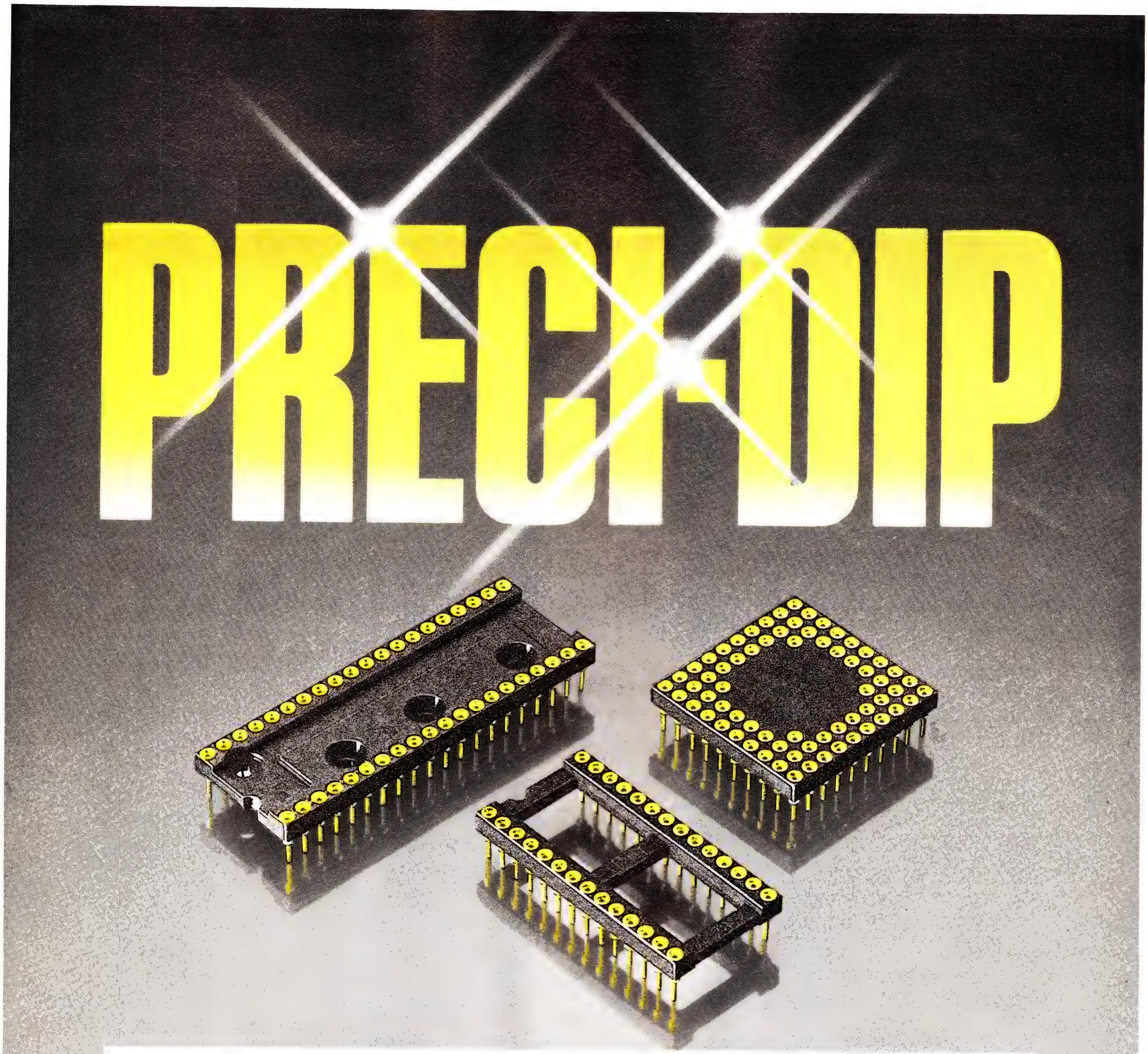
The system runs under the OS-9/68000 operating system and comes with Basic09, a structured Basic language compiler; the Dynacalc spreadsheet program; and the Stylegraph word-processing system. Available 30 days after ordering, the computer board is priced at $995 each.



Hazelwood Computer Systems, 907 E. Terra, O'Fallon, Mo. 63366.
Phone (314) 281-1055 [Circle 379]

VMEBUS COMPUTER USES 68010

Available now, the V68F VMEbus single-board computer has up to 1 megabyte of dual-ported RAM with byte parity. The V68F's no-wait-state demand-paged virtual memory management unit enhances multitasking, multiuser, or real-time operating systems that require fast-context switching.



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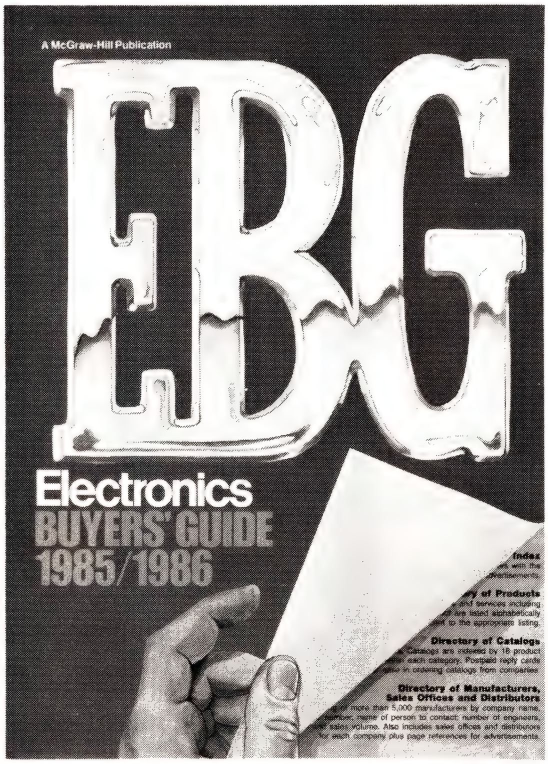
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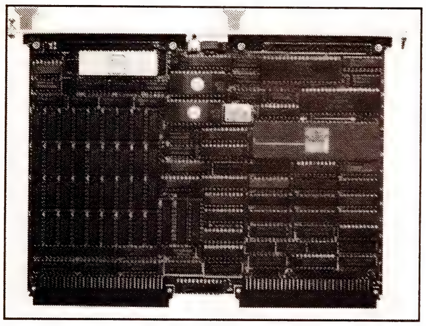

In addition to the RAM, the computer, which is built around the 68010, has programmable ROM and a Small Computer Systems Interface controller. The controller is a buffered, full SCSI-specification I/O port that gives a 1.5-Mb/s transfer rate with interrupt and pseudodirect memory access.

The board has six levels of autovectored interrupts for on-board devices and accommodates seven levels of vectored bus interrupts from the VMEbus and one separately autovectored mailbox interrupt.

Standard with 256-K bytes of RAM, the V68F sells for $2,475 each.

Pacific Microcomputers Inc., 160 Chesterfield Dr., Cardiff, Calif. 92007.
Phone (619) 436-8649 [Circle 380]

MICROVAX II GETS MEMORY CARDS

Add-in memory cards for Digital Equipment Corp.'s Microvax II computer are now available with capacities of either 2 or 4 megabytes. The MVXII-2MB and MVXII-4MB are quad-height cards that contain 256-K-byte RAM chips.

The cards are compatible with the Microvax II hardware and operating systems, and they support all Microvax II memory-system features including diagnostics and parity checking.

The 2-megabyte board sells for $2,800 and the 4-megabyte card goes for $5,100. Each board can be supplied with memories that are housed in sockets or soldered in place.

EMC Corp., 12 Mercer Rd., Natick, Mass. 01760. Phone (617) 655-6600 [Circle 382]

VMEBUS CPU HAS 16-K BYTES OF SRAM

The PME 68-2 VMEbus single-board computer has 16-K bytes of high-speed static RAM and as much as 1 megabyte of dual-ported dynamic RAM. The 68000-based computer has an on-board real-time clock that is programmable in increments as short as 0.001 s and as long as 1 month.

The PME 68-2 board's floppy-disk controller runs up to four 5¼-in. disk drives in both single- and double-density for-

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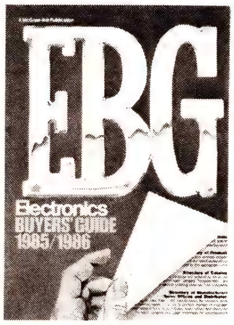

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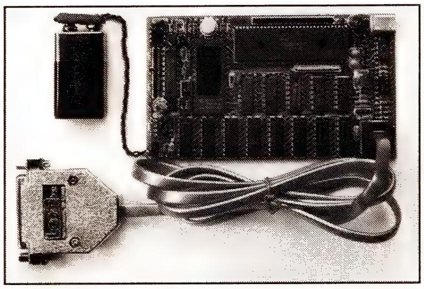
mats. The board features an RS-232-C serial port, a single-level bus arbiter, full seven-level interrupt capability, and up to 64-K bytes of firmware containing the system-monitor software.

Available from stock, the standard board with 512-K bytes of RAM and 10-MHz processor is priced at $1,850. A depopulated version, the 68-2D, with 128-K bytes (expandable to 256-K bytes) and a 10-MHz chip, sells for $1,269.

Plessey Microsystems, 1 Blue Hill Plaza, Pearl River, N. Y. 10965.
Phone (914) 735-4661 [Circle 381]

BOARD HAS BASICS OF DATA LOGGER

The Tattletale model II board needs only sensors, a box, and a logging program written in Basic to become a low-power portable data logger. Weighing just 3 oz., Tattletale II offers eight channels of 8-bit analog-to-digital conversion capacity, including on-board temperature and battery sensing, 14 I/O lines, and 224-K bytes of data capacity. The board runs from a 9-V power supply.



The logger comes with an RS-232-C cable for connection to an IBM Corp. Personal Computer or compatible, and a signal-conditioning prototyping card for the analog and digital circuits. Unit-priced at $895, the Tattletale II will be shipped in six weeks.

Onset Computer Corp., 199 Main St., P. O. Box 1016, North Falmouth, Mass. 02556.
Phone (617) 563-2267 [Circle 373]

SIGNAL-PROCESSOR CARD FITS IN IBM PC

Fitting inside the IBM Corp. Personal Computer, PC/XT, or PC AT, the PC-320 serves as a complete digital signal-processing system for such applications as speech recognition, acoustical signal processing, vibration analysis, and waveform generation.

The board's 20-MHz TMS-32010 single-chip digital signal microprocessor executes 5 million instructions/s. The chip, a 16-by-16 parallel multiplier, performs multiplication and accumulation in 400 ns in flow-through mode and 200 ns in pipeline mode.

Changing the function of the PC-320 merely requires downloading a new program and replacing an interface module. Priced at $995, the board is available now.

Tiac Manufacturing Inc., 3084 Spring St., Port Moody, British Columbia, Canada V3H 1Z8. Phone (604) 461-1626 [Circle 384]

DC-TO-DC CONVERTER HAS 90% EFFICIENCY

A 50-W dc-to-dc converter boasts a 90% efficiency rating. The model PS-4572 accepts a 42-to-56-V dc input and delivers outputs of either 200 or ±100 V dc.

The output is protected against overvoltages and the supply is protected against short circuits both to ground and between dual outputs. The converter, which switches at a 100-kHz frequency, has a load regulation to ±2% from full load to ¼-load and line regulation to ±2% over the full input range.

Available from stock, the PS-4572 sells for $176.40 each in quantities of 100.

Computer Products, Stevens-Arnold Division, 7 Elkins St., South Boston, Mass. 02127. Phone (617) 268-1170 [Circle 376]

AC POWER SOURCES PROVIDE 9 kVA

A line of frequency-changing, sine-wave ac power sources, rated from 1 kVA to 9 kVA in one-, two-, and three-phase configurations, powers high-current-consuming equipment. Electronic gear, usually powered by dc supplies with rectifiers and capacitive input filters, draw all their current in small amounts at the peak of each cycle.

But the new power sources deliver a peak current up to 3.5 times the root-mean-square value, which means sources rated at 10 A output can provide 35 A peak current, reducing the need to overspecify the size of the sources.

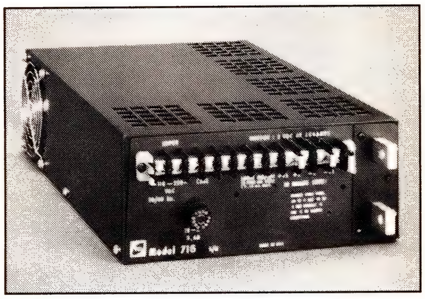
Output voltage and frequency can range from 0 to 260 V ac and 47 to 500 Hz. Available in 30 days, the basic model sells for $2,115.

Diego Power Sources, Eastgate Industrial Center, 5350 Eastgate Mall, San Diego, Calif. 92121.
Phone (619) 587-1925 [Circle 377]

COMPACT SUPPLY DELIVERS 750 W

The model 715 switching power supply delivers 750 W from a package that measures 3.3 by 8.0 by 13.5 in., achieving a power density of more than 2 W/in.^{3} The supply delivers 5 V at 150 A but units can be put in parallel for higher current requirements.

The model 715 has a dual-input range of 105 to 130 V ac or 198 to 265 V ac selectable from the barrier strip. It has overvoltage protection, current limiting, and short-circuit protection.



For single units, the supply's $750 price is $1 per watt. Discounts are available on larger quantities. Delivery is from stock.

RO Associates Inc., 246 Caspian Dr., P. O. Box 61419, Sunnyvale, Calif. 94088.
Phone (408) 744-1450 [Circle 375]

GKS SOFTWARE MOVES TO MAINFRAMES

The Graphics Kernel System is moving to mainframe computers, thanks to ISSCO-GKS. The level 2B implementation of the standard runs on a number of 32-bit machines, minicomputers, and mainframes including models from Apollo, Hewlett-Packard, IBM, and Digital Equipment Corp.'s Microvax II.

The software supports more than 225 graphics peripherals, according to the developer, and the company's Disspla and Tell-a-graf software can share metafiles in ISSCO-GKS. Depending on the user's computer, ISSCO-GKS software ranges from $400 to $9,300.

Integrated Software Systems Corp., 10505 Sorrento Valley Rd., San Diego, Calif. 92121. Phone (619) 452-0170 [Circle 352]

SIMULATION SOFTWARE DEBUGS OFF-LINE

With Testsim, a simulator for the J941 very large-scale-integration test system, an engineer can run any J941 test-program object file, the master operating program, or the test-analysis program—the on-line system debugger—on a VAX computer. Offloading the debugging process sets the test system free to test ICs, for significant savings in time and production revenue. Also, Testsim can run in batch mode; thus operators can use their computer time flexibly.

Testsim uncovers semantic errors that might direct the test system to attempt physically impossible or potentially unsafe actions, and it also checks for timing hazards, memory-access violations, and dc inconsistencies. If the engineer wants to clarify timing relationships, Testsim can display waveform plots for any range of expanded vectors. A primary license for the behavioral-level software costs $50,000, and delivery is in four weeks.

Teradyne Inc., Inquiry Systems and Analysis, 660 Summer St., Building 114, Box 120, Boston, Mass. 02210. [Circle 353]

EXPERT SYSTEM RUNS ON PC 7300

Rulemaster expert-system development software is now available on AT&T Co. Unix PC 7300 computers for business environments and on Tektronix 4404 computers for the scientific and engineering community. The package supports pipes, to access external data bases and incorporate program modules written in other languages. Data from measuring devices can also be piped into the system for real-time applications.

Rulemaster's Rulemaker facility automatically creates rules based on examples of expert decision making, then generates code in Radial, a proprietary structured language. Then, since the programmer can organize an application as a hierarchy of independent modules, the application can be rationalized into a series of subtasks, each capable of independent debugging.

Licenses sell for $15,000 or $25,000, depending on the computer. Another version, Rulemaster/PC, runs on the IBM Corp. PC/XT and PC AT.

Radian Corp., 8501 Mo-Pac Blvd., P. O. Box 9948, Austin, Texas 78766.
Phone (512) 454-4797 [Circle 354]

68020 PROCESSOR GETS UNIX

Uniplus+ System V release 2 is available now for the 68000 microprocessor family, including the 32-bit 68020. The software meets AT&T Co.'s announced standards for all future versions of release 2 and includes a compatability mode that creates a transition between Uniplus+ System V and this release.

Enhancements in Release 2 include a common object-file format (COFF) that increases compatibility across different microprocessors, and a C compiler that supports COFF and gives fast floating-point processing. Release 2 also incorporates shell layering, equivalent to the job-control function in Unix 4.2bsd. Nroff and troff text- and document-processing systems have been retained, and Release 2 is preconfigured to support B-Net networks (an option). Pricing varies widely, based on the hardware configuration.

Unisoft Systems, 739 Allston Way, Berkeley, Calif. 94710.
Phone (415) 644-1230 [Circle 355]

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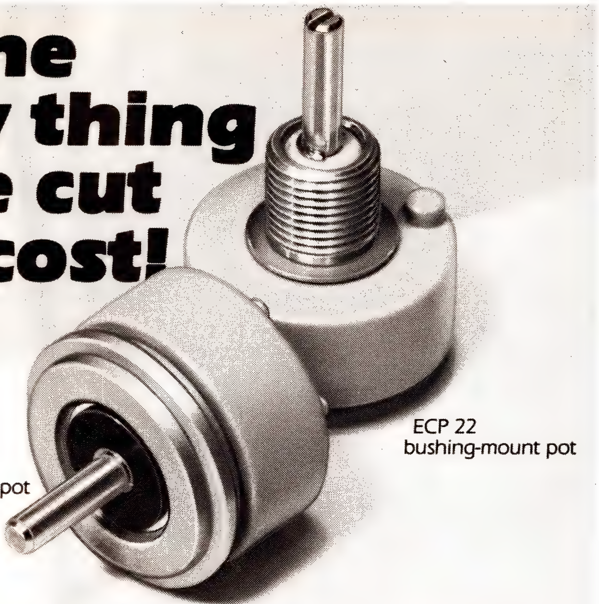

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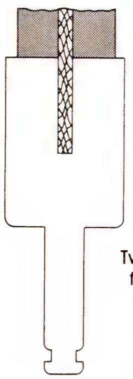
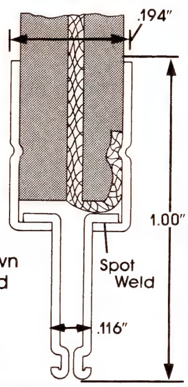
Circle 111 on reader service card

PIN MONEY



PART:
Pin contact
ANNUAL PRODUCTION QUANTITY:
500,000 pieces
◄ BEFORE:
Pin was machined from solid brass. Conductor, soldered in place, tended to break when pin was moved.
AFTER: ►
Two pieces were deep drawn from stainless steel strip and welded. Conductor was crimped into place (4 pin crimps), eliminating breakage problem.



MANUFACTURING COST BEFORE: **23¢**
MANUFACTURING COST AFTER: **13.5¢**

This pin contact is real proof of how we help manufacturers reduce costs. We can frequently accomplish major savings, for example, by replacing machining with deep drawing where no one thought it could be done.

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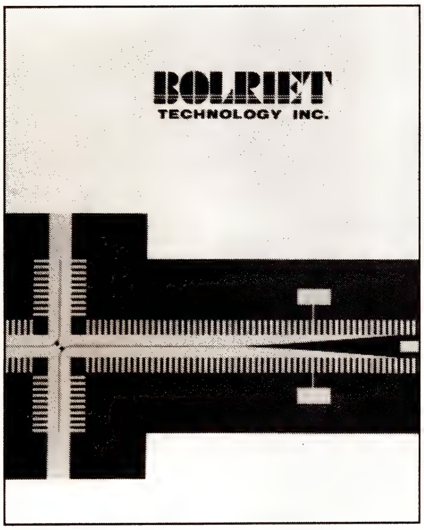

MICROWAVE ICs. A free brochure from Bolriet discusses microwave ICs made with a proprietary thin-film process. The company produces circuits with plated through holes with a minimum diameter of 0.005 in., lines down to 1 mil wide, and spaces with a tolerance of ±2 μm on polytetrafluoroethylene. The soft-substrate material offers dielectric constants ranging from 2.17 to 10.5. This technology suits applications in the higher frequency ranges, as for power dividers, phase shifters, and filters. Requests should be sent to Bolriet Technology Inc., Rogers Corp., P. O. Box 300, Chandler, Ariz. 85224. Phone (602) 961-1382. [Circle reader service number 421]

WORK STATIONS. Modular work stations for light manufacturing are illustrated in a color brochure. The designs include all necessary work surfaces, storage shelves, tools, and tool holders for each assembly process. The work stations come with a six-wire, three-circuit electrical system built into the panel Beltline raceway, which also accommodates a delivery system for air, vacuum, and inert gas. The literature is free from the Ergo-Tech Systems Division of Panel Concepts Inc., P. O. Box C-25100, Santa Ana, Calif. 92799. Phone (714) 979-3680. [Circle 428]

HIGH RELIABILITY. "High-Reliability Products" contains technical data and other information on CMOS logic, QMOS logic, linear ICs, and other components designed for military, aerospace, industrial, and scientific applications. All comply with MIL-STD-883 Revision C. One section of the brochure describes radiation effects on ICs in hostile environments. Write to RCA Corp., Solid State Division, P. O. Box 2900, Somerville, N. J. 08876 for a free copy of publication HRP-479C.

TEST SYSTEMS. A free catalog features 15 generic factory test systems selected from over 150 of Giordano Associate's test stations and ranks them from medium to large scale and whether they are analog, digital, or hybrid. Applications range from telecommunications to aerospace testing. Selection of any model carries a minimum penalty of nonrecurring engineering costs, since each model is a repeat of an existing and proven test system. Request a copy of "New Dimensions in Functional Testing" from Instrumentation Engineering, 769 Susquehanna Ave., Franklin Lakes, N. J. 07417, or call the company at (201) 891-9300. [Circle 423]

CAPACITORS. A six-page data sheet details the specifications for subminiature tantalum capacitors that meet or exceed MIL-C-49137/6. The company has nonpolar and polar types with ratings from 0.22 to 470 μF and 2 to 35 V dc. To receive a free copy, write to Tansitor Electronics Inc., P. O. Box 230, Bennington, Vt. 05201. Phone (802) 442-5473. [Circle 429]

INSULATION. The properties of the two most commonly used ribbon-cable insulating materials—polyvinyl chloride and polytetrafluoroethylene—are summarized in a technical report titled "Environmental Considerations for Ribbon Cables." A two-page table covers temperature, ultraviolet exposure, mechanical problems caused by abrasion, and resistance to chemicals and ozone. The report goes on to tabulate the environmental specifications for the above materials. For a free copy, call W. L. Gore & Associates Inc. at (602) 431-0077. The mailing address is 4747 E. Beautiful La., Phoenix, Ariz. 85076. [Circle 426]

CABLE. A brochure on the advantages of woven cable devotes sections to flat-ribbon cable, controlled-impedance cable, and custom-woven harness and jumper assemblies. Also included are robotics cables that permit in-and-out motion and 180° rotation, superflex and flat-to-round cables, proprietary Dense-Pak cable, and many other configurations. "Weaving: The Signal Is Clear" comes free from Woven Electronics, P. O. Box 189, Mauldin, S. C. 29662. Phone (803) 963-5131. [Circle 425]

MAGNETICS. Prem Magnetics Inc. offers "Magnetics for Telecommunications," a catalog that details its voice and data products. Included are coupling transformers in both regular and low-profile models and feed-bridge inductors. In its custom line, Prem offers inductors, power transformers, and linearity and width coils for CRT terminals. For a free copy, write to 3521 N. Chapel Hill Rd., McHenry, Ill. 60050. Phone (815) 385-2700. [Circle 427]

COLOR PLOTTERS. "Electrostatic Color Plotters—the Choice in Hard Copy Output" provides descriptions, block diagrams, and photographs of Versatec's 24- and 36-in. color plotters. These peripherals plot 200 points/in. and have applications in solids modeling, printing, engineering designs, business graphics, output of seismic data, and mapping. Electrostatic plotting speed is not affected by data density, the company says, and subtle color shading presents no problem. Copies of the brochure are free from Versatec Inc. at 2710 Walsh Ave., Santa Clara, Calif. 95051. The toll-free numbers are (800) 538-6477 or (800) 341-6060. [Circle 430]

HARD DISK. Technical Note 6-4 features artwork and schematics for a hard-disk controller subsystem using the HDC 9226 hard-disk data separator. By releasing the artwork for the entire front end of a Winchester drive subsystem, the manufacturer says it has eliminated the mystery from its design. Request this free literature from Standard Microsystems Corp. at (516) 273-3100, or write to the Standard Products Marketing Department, 35 Marcus Blvd., Hauppauge, N. Y. 11788. [Circle 422]

PUSHBUTTONS. A 32-page brochure covers Telemecanique's line of pushbuttons, pilot lights, and selector switches. The products meet National Equipment Manufacturers Association standards for harsh environments; they are even watertight under pressure-wash conditions. Illuminated and nonilluminated designs are included. The catalog has descriptions, dimensions, and prices; it's free from Telemecanique Inc., c/o Business Services Inc., 902 Feehanville Dr., Mount Prospect, Ill. 60056. [Circle 431]

BOOKS

MOTOROLA 32-BIT MICROPROCESSOR USER'S MANUAL

Motorola Inc.
$5.20/464pp

Motorola's latest release on the popular 68000 microprocessor, a full 32-bit processor, suits hardware designers and software developers. The complete, concise description of the various hardware modes for the MC68020 will ease hardware design. The manual clearly explains and illustrates operations such as the length of the bus cycle. It also covers how to connect the MC68020 with coprocessors and gives board-mounting specifications and operating conditions.

For the software designer, the chip's memory operations are clearly explained, including why the chip will perform more efficiently when memory operations use even-address and long-integer (4 bytes) operations. This makes the manual especially useful to the systems analysts or programmer involved in such subjects as compiler design. The manual also presents various levels of privilege use supported by the chip.

DEFENSE CONTRACT TERMINATION GUIDE

Government Procurement Relations Council
Electronic Industries Association
$25 (members), $40 (nonmembers)/100pp

This new edition from the Government Procurement Relations Council of a standard reference for prime contractors and subcontractors will help companies unfamiliar with contract termination—that is, fulfillment—and whose procedures are not established along defense business lines. The guide reflects the procedures outlined in the Federal Acquisition Regulations and the Department of Defense Supplements. These center on termination by the DOD as governed by Part 49 of the FAR.

IMAGE SCIENCE '85

Acta Polytechnica Scandinavica
Finnish Academy of Technical Sciences
Fmk 100.00 (series)/292pp

These proceedings of a conference that was held in Helsinki, Finland, in June 1985, deal with the principles and applications of optical and digital imaging. Volume 2, which is noted here and is available now, consists of about 200 contributed papers that cover applications in such areas as tomography, imaging in robotics, satellite imaging, and acoustical imaging. Volume 1, which is forthcoming, will present the text of lectures on such conference topics as holography, imaging methods, and components and systems.

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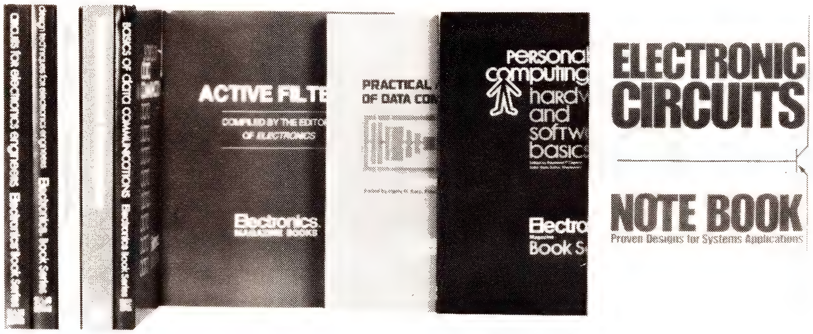
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Microelectronics Interconnection and Packaging
Articles from *Electronics* include sections on lithography and processing for integrated circuits, thick- and thin-film hybrids, printed-circuit-board technology, automatic wiring technology, IC packages and connectors, environmental factors affecting interconnections and packages, computer-aided design, and automatic testing. Pub. 1980, 321 pages, softcover.
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This compilation of essential articles from *Data Communications* magazine includes chapters on terminals, acoustic couplers and modems, communications processors, networking, channel performance, data link controls, network diagnostics, interfaces, and regulations and policy. Pub. 1976, 303 pages, softcover.
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NAME/TITLE of individual to be contacted **Your Signature**

NAME OF ORGANIZATION **Telephone (our use only)**

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Note: Last date coupons can be accepted for this year's summer job listings is November 20, 1985

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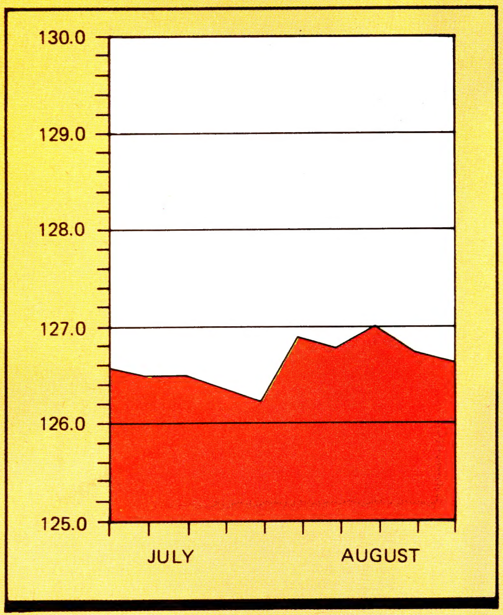
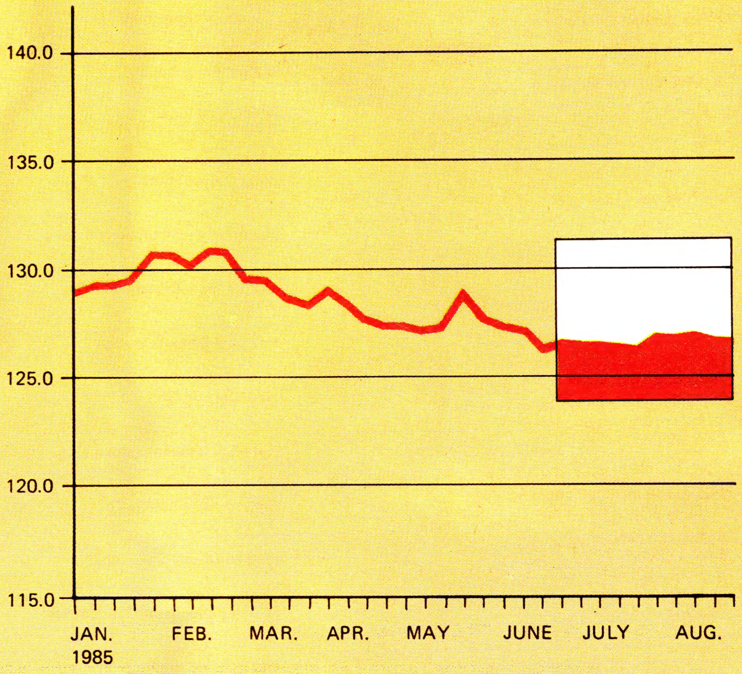




THIS WEEK = 126.6
LAST WEEK = 126.7
YEAR AGO = 130.3
1982 = 100.0

The *Electronics* Index, a seasonally adjusted measure of the U.S. electronics industry's health, is a weighted average of various indicators. Different indicators will appear from week to week.

U. S. ELECTRONICS IMPORTS & EXPORTS ($ MILLIONS)

	IMPORTS			EXPORTS		
	June 1985	**May 1985**	**June 1984**	**June 1985**	**May 1985**	**June 1984**
Accounting, computing, and data-processing machines	269.256	300.963	296.628	623.101	637.633	578.646
Calculators	40.132	47.993	45.740	6.156	6.682	6.760
Parts for data-processing machines and office calculators	358.962	325.539	328.999	599.545	624.791	521.358
Telecommunications, sound-recording, and sound-reproducing equipment	1,497.511	1,460.503	1,212.517	346.595	363.261	310.428
Electronic or electric instruments	149.080	141.211	110.383	568.997	559.852	499.349
Printed-circuit boards	24.639	15.666	19.823	25.035	28.887	19.446
Integrated circuits, diodes and other semiconductors, tubes, piezoelectric crystals, parts	550.792	498.928	633.579	402.142	452.540	481.575
Fixed and variable resistors	20.716	20.139	26.910	13.101	14.530	17.101

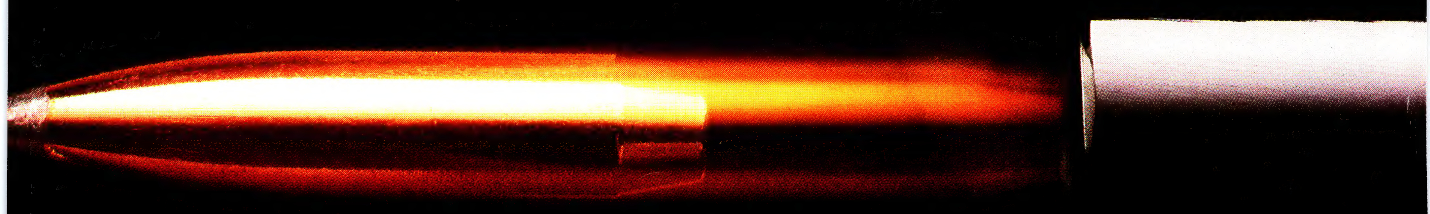
Another dip in the balance of trade in electronic equipment brought the *Electronics* Index down 0.1% in the latest week. It now stands at its lowest point in over a month. The 3.6% increase in imports and the 3.8% decline in exports by U. S. companies were not large in themselves. Yet they brought the U. S. trade deficit in electronic equipment for June to $326 million—which was more than double May's $122.8 million deficit.

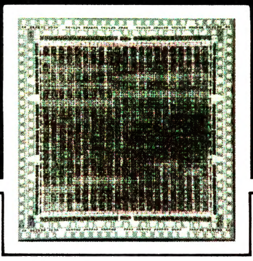
U. S. electronic-equipment manufacturers lost ground overseas in June across most product lines. The exception was instruments, where exporting companies squeezed out a 1.6% increase in overseas shipments. With an 11% drop in exports, semiconductor manufacturers experienced the most drastic loss in overseas markets.

Foreign producers, however, managed some hefty gains in U. S. markets in June (the latest month for which statistics are available). Though imports of calculating machines dropped 17%, imports of accounting machines, computers, and related parts rose over 10%. Imports of printed-circuit boards soared 57% in June. U. S. chip vendors also swallowed some bad news: imports of semiconductors increased more than 10% in the month.

SPEED

The most meaningful refinement of accuracy
is reducing the time it takes.





The more tasks a microchip performs, the more critical its speed becomes.

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Kepco's Series ATE **Power Managers,** interfaced to an IEEE bus through Kepco Series SN Digital Programmers, manage all controlled power requirements in Harris' Hybrid and Avionic Test Systems, furnishing the critical programmed test voltages to the unit under test.

Kepco **Power Managers** are fully programmable for both voltage and current through their entire rated range, and can deliver full-rated current *and* full-rated voltage at the same time.

For your ATE requirements, unipolar or bipolar, up to 2000 Volts and 1000 Watts, consider Kepco's versatile **Power Managers.**

Circle 902 on reader service card

This Harris AN/USM-484 Hybrid Test System incorporates 10 Kepco power supplies:

- three Kepco ATE 36-3M (0-36 Volts, 0-3 Amps)
- three ATE 100-1M (0-100 Volts, 0-1 Amp)
- one ATE 25-4M (0-25 Volts, 0-4 Amps)
- one ATE 6-10M (0-6 Volts, 0-10 Amps)
- one ATE 15-6M (0-15 Volts, 0-6 Amps)
- one ATE 55-2M (0-55 Volts, 0-2 Amps)

Programming these Power Managers to the appropriate test levels are one single channel Kepco SN 488-121, and four dual channel SN 488-122 digita interfaces that read their instructions from Harris' IEEE 488 bus and provide optically isolated commands to the Kepco Power Managers.

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